UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VOLKSWAGEN GROUP OF AMERICA, INC.,
Petitioner,

v.

LONGHORN AUTOMOTIVE GROUP LLC,
Patent Owner.

IPR2025-01064
U.S. Patent 8,265,353

DECLARATION OF TODD PETERSON, PH.D.

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1. [1p] A method of forming an image of a mobile object, comprising: 80

2. [1a-i] obtaining a plurality of first images of the mobile object using a first imaging technique; 85

3. [1a-ii] while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system; 90

4. [1a-iii] the first sensor system being independent from the first imaging technique; 98

5. [1b] associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements; 104

6. [1c-i] obtaining a plurality of second images of the mobile object using a second imaging technique 110

7. [1c-ii] while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system.....123

8. [1c-iii] the second sensor system being independent from the second imaging technique; 129

9. [1d] associating the plurality of second images with second movement states of the mobile object using the first [sic] measurements; and 134

10. [1e] forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states, ...153

11. [1f] wherein the first imaging technique is different from the second imaging technique. 162

C. Claim 2 [2] The method of claim 1, further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time

scale being determined by a comparison between the first and second movement states. 162

D. Claim 3 [3] The method of claim 1, further comprising: forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images. 167

E. Claim 4 [4] The method of claim 3, further comprising: spatially-synchronizing said first reconstructed images and said second reconstructed images. 168

F. Claim 5 [5] The method of claim 1, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique. 170

G. Claim 6 [6] The method of claim 1, further comprising: spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements. 170

H. Claim 7 [7] The method of claim 1, further comprising: forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements. 171

I. Claim 8 [8] The method of claim 7, wherein said forming an image of the mobile object comprises combining said displacement fields. 175

J. Claim 9 [9] The method of claim 7, wherein said forming displacement fields comprises: estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields. 178

K. Claim 10 [10] The method of claim 9, wherein at least one of said movement estimates is formed relative to a reference time. 180

L. Claim 11 [11] The method of claim 1, wherein the first sensor system is different from the second sensor system. 180

M. Claim 12 181

1. [12p] An apparatus to form an image of a mobile object, comprising:.....181

2. [12a-i] means for obtaining a plurality of first images of the mobile object using a first imaging technique;.....181

3. [12a-ii] means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images, ...182

4. [12a-iii] the means for obtaining the plurality of first measurements being independent from the first imaging technique; 183

5. [12b] means for associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;.....183

6. [12c-i] means for obtaining a plurality of second images of the mobile object using a second imaging technique;.....185

7. [12c-ii] means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images, ...186

8. [12c-iii] the means for obtaining the plurality of second measurements being independent from the second imaging technique;.....187

9. [12d] means for associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements; and.....187

10. [12e] means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,.....189

11. [12f] wherein the first imaging technique is different from the second imaging technique. 191

N. Claim 13 [13] The apparatus of claim 12, further comprising: means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images. 191

O. Claim 14 [14] The apparatus of claim 12, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique. 193

P. Claim 15 [15] The apparatus of claim 12, further comprising: means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements. 193

Q. Claim 16 [16] The apparatus of claim 15, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields. 195

R. Claim 17 [17] The apparatus of claim 15, wherein said means for forming displacement fields comprises: means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields. 195

S. Claim 18 [18] The apparatus of claim 17, wherein at least one of said movement estimates is to be formed relative to a reference time. 197

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A. Ground 2 Overview: Weese in view of Muehllehner 197

B. [1c-i] obtaining a plurality of second images of the mobile object using a second imaging technique 202

C. [12c-i] means for obtaining a plurality of second images of the mobile object using a second imaging technique; 204

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1. [1p] A method of forming an image of a mobile object, comprising: 215

2. [1a-i] obtaining a plurality of first images of the mobile object using a first imaging technique; 216

3. [1a-ii] while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system; 217

4. [1a-iii] the first sensor system being independent from the first imaging technique; 220

5. [1b] associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements; 220

6. [1c-i] obtaining a plurality of second images of the mobile object using a second imaging technique 221

7. [1c-ii] while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system 222

8. [1c-iii] the second sensor system being independent from the second imaging technique 225

9. [1d] associating the plurality of second images with second movement states of the mobile object using the first [sic] measurements; and 225

10. [1e] forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states, ...228

11. [1f] wherein the first imaging technique is different from the second imaging technique. 234

C. Claim 2 [2] The method of claim 1, further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states. 235

D. Claim 3 [3] The method of claim 1, further comprising: forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images. 236

E. Claim 4 [4] The method of claim 3, further comprising: spatially-synchronizing said first reconstructed images and said second reconstructed images. 237

F. Claim 5 [5] The method of claim 1, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.....239

G. Claim 6 [6] The method of claim 1, further comprising: spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements.....239

H. Claim 7 [7] The method of claim 1, further comprising: forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements,

said plurality of second images, and said plurality of second measurements. 240

1. Weese-Wainer's registration renders obvious [1e]....241

2. The motion model of Weese-Wainer renders obvious claim 7. 242

I. Claim 8 [8] The method of claim 7, wherein said forming an image of the mobile object comprises combining said displacement fields. 247

J. Claim 9 [9] The method of claim 7, wherein said forming displacement fields comprises: estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields. 247

K. Claim 10 [10] The method of claim 9, wherein at least one of said movement estimates is formed relative to a reference time. 249

L. Claim 11 [11] The method of claim 1, wherein the first sensor system is different from the second sensor system. 250

M. Claim 12 251

1. [12p] An apparatus to form an image of a mobile object, comprising:....251

2. [12a-i] means for obtaining a plurality of first images of the mobile object using a first imaging technique; 251

3. [12a-ii] means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images, ...252

4. [12a-iii] the means for obtaining the plurality of first measurements being independent from the first imaging technique; 253

5. [12b] means for associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;.....253

6. [12c-i] means for obtaining a plurality of second images of the mobile object using a second imaging technique;.....255

7. [12c-ii] means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images, ...256

8. [12c-iii] the means for obtaining the plurality of second measurements being independent from the second imaging technique;.....257

9. [12d] means for associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements; and.....257

10. [12e] means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,.....259

11. [12f] wherein the first imaging technique is different from the second imaging technique. 260

N. Claim 13 [13] The apparatus of claim 12, further comprising: means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images. 260

O. Claim 14 [14] The apparatus of claim 12, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique. 261

P. Claim 15 [15] The apparatus of claim 12, further comprising: means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements. 261

Q. Claim 16 [16] The apparatus of claim 15, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields. 262

R. Claim 17 [17] The apparatus of claim 15, wherein said means for forming displacement fields comprises: means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields. 263

S. Claim 18 [18] The apparatus of claim 17, wherein at least one of said movement estimates is to be formed relative to a reference time. 264

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A. Claim 1 264

1. [1p] A method of forming an image of a mobile object, comprising:....264

2. [1a-i] obtaining a plurality of first images of the mobile object using a first imaging technique; 265

3. [1a-ii] while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system;....266

4. [1a-iii] the first sensor system being independent from the first imaging technique; 268

5. [1b] associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements; 268

6. [1c-i] obtaining a plurality of second images of the mobile object using a second imaging technique 269

7. [1c-ii] while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system.....270

8. [1c-iii] the second sensor system being independent from the second imaging technique.....272

9. [1d] associating the plurality of second images with second movement states of the mobile object using the first [sic] measurements; and 273

10. [1e] forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states, ...275

11. [1f] wherein the first imaging technique is different from the second imaging technique. 282

B. Claim 2 [2] The method of claim 1, further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states. 282

C. Claim 3 [3] The method of claim 1, further comprising: forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images. 283

D. Claim 4 [4] The method of claim 3, further comprising: spatially-synchronizing said first reconstructed images and said second reconstructed images. 284

E. Claim 5 [5] The method of claim 1, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique. 285

F. Claim 6 [6] The method of claim 1, further comprising: spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements. 285

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H. Claim 8 [8] The method of claim 7, wherein said forming an image of the mobile object comprises combining said displacement fields. 288

I. Claim 9 [9] The method of claim 7, wherein said forming displacement fields comprises: estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields 288

J. Claim 10 [10] The method of claim 9, wherein at least one of said movement estimates is formed relative to a reference time. 290

K. Claim 11 [11] The method of claim 1, wherein the first sensor system is different from the second sensor system. 290

L. Claim 12 291

1. [12p] An apparatus to form an image of a mobile object, comprising: 291

2. [12a-i] means for obtaining a plurality of first images of the mobile object using a first imaging technique;.....291

3. [12a-ii] means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images, ...292

4. [12a-iii] the means for obtaining the plurality of first measurements being independent from the first imaging technique;.....292

5. [12b] means for associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;.....293

6. [12c-i] means for obtaining a plurality of second images of the mobile object using a second imaging technique;.....293

7. [12c-ii] means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images, ...294

8. [12c-iii] the means for obtaining the plurality of second measurements being independent from the second imaging technique;.....295

9. [12d] means for associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements; and.....295

10. [12e] means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,.....297

11. [12f] wherein the first imaging technique is different from the second imaging technique. 298

M. Claim 13 [13] The apparatus of claim 12, further comprising: means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images. 298

N. Claim 14 [14] The apparatus of claim 12, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique. 299

O. Claim 15 [15] The apparatus of claim 12, further comprising: means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements. 299

P. Claim 16 [16] The apparatus of claim 15, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields. 300

Q. Claim 17 [17] The apparatus of claim 15, wherein said means for forming displacement fields comprises: means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields. 301

R. Claim 18 [18] The apparatus of claim 17, wherein at least one of said movement estimates is to be formed relative to a reference time. 302

XVI. CONCLUSION.....302

I. INTRODUCTION

[001] I have been retained by Volkswagen Group of America, Inc. as an independent expert for the above-identified inter partes review proceeding involving U.S. Patent No. 8,263,353 ("the '353 patent").

[002] I am over 21 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein.

[003] Although I am being compensated for my time in connection with this proceeding at my standard hourly consulting rate and reimbursed for reasonable out-of-pocket expenses, no part of my compensation depends on the outcome of this proceeding, and I have no other interest in this proceeding.

[004] I have been asked to provide my opinion whether the claims of the '353 patent would have been obvious to a person of ordinary skill in the art at the time of the earliest claimed priority date of the '353 patent. In performing my analysis, I have been asked to assume that the priority date is October 1, 2003. My opinions are set forth below.

[005] Throughout this declaration, I refer to specific pages, figures, and/or line numbers of various exhibits. These citations are illustrative and are not intended to suggest that they are the only support for the propositions for which they are cited.

II. SUMMARY OF OPINIONS

[006] This declaration analyses claims 1-18 of the ’353 patent. Below, I set forth the opinions I have formed, the conclusions I have reached, and the bases for my opinions and conclusions. I believe the statements contained in this declaration to be true and correct to the best of my knowledge.

[007] Based on my experience and knowledge of the art at the time of the applicable priority date (I was told to assume a priority date of October 1, 2003), it is my opinion that claims 1-18 of the ’353 patent would have been obvious based on the asserted grounds discussed below.

III. QUALIFICATIONS AND BACKGROUND

[008] Here, I provide a brief summary of my background and qualifications. I believe that I am well qualified to serve as a technical expert in this matter, as discussed in detail below, and I am competent to provide this Declaration. A copy of my curriculum vitae more fully detailing my credentials is attached as Ex-1004.

[009] I am currently employed at the Vanderbilt University Medical Center as a Professor of Radiology and Radiological Sciences, where I also serve as Director of Nuclear Imaging in the Vanderbilt University Institute of Imaging Science and as Director of the Animal and Human Imaging Shared Resource for Vanderbilt-Ingram Cancer Center. After receiving a PhD in experimental nuclear physics from Indiana University, I began my career in biomedical imaging research

as a postdoc in the University of Arizona's Center for Gamma-Ray Imaging from 2000 to 2003. At that time the Center for Gamma-Ray Imaging was a leader in the move toward the collection of list-mode data in nuclear imaging, which provides improved flexibility in reconstructing dynamic data and motion correction, and I collaborated with POSITAs—as defined below—working on image reconstruction. I have over 24 years of experience in biomedical imaging research and have been involved in conducting PET/CT and SPECT/CT imaging studies for 22 years, participating in their design, execution, and analysis. My research interests extend from the development of semiconductor radiation detectors for high-resolution nuclear imaging to preclinical and clinical applications of PET, SPECT, and CT imaging in oncology, neurology, pharmacology, and diabetes. For example, my research has included the development of high-resolution, multi-pinhole SPECT capabilities, and the use of CT, SPECT, and PET in preclinical and clinical research studies across a wide range of applications. Together with research assistants, I have developed novel semiconductor radiation detector technology for use in innovative multi-pinhole SPECT systems. I have also been involved in a number of collaborative projects in which my and my assistants' role was to refine and validate image acquisition and analysis techniques to improve quantitative PET and SPECT capabilities.

[010] A current copy of my curriculum vitae, Ex-1004 provides further information concerning my experience and qualifications. It includes a list of my patents, a list of the publications I have authored, and a list of matters on which I have served as an expert witness.

IV. MATERIALS CONSIDERED

[011] In forming my opinions, I have read and considered the ’353 patent and its prosecution history, the exhibits listed in the Exhibit List filed with the petition for inter partes review of the ’353 patent, as well as any other materials referenced herein. I have reviewed at least the following documents:

Exhibit	Description
Ex-1001	U.S. Patent No. 8,265,353 (“the ’353 patent”)
Ex-1002	Prosecution History of the ’353 Patent
Ex-1005	U.S. Patent Publication No. 2005/0226527 to Weese et al. (“Weese”)
Ex-1006	U.S. Patent No. 5,744,802 to Muehllehner et al. (“Muehllehner”)
Ex-1007	U.S. Patent No. 5,871,013 to Wainer et al. (“Wainer”)

Ex-1008	Bushberg, Jerrold T., et al. *The essential physics of medical imaging*. Lippincott Williams & Wilkins. 2d Ed. 2002.
Ex-1009	Mattes, David, et al. "Nonrigid multimodality image registration." *Medical imaging 2001: image processing*. Vol. 4322. Spie, 2001.
Ex-1010	Katsaggelos, Aggelos K. "Iterative image restoration algorithms." *Optical engineering* 28.7 (1989): 735-748.
Ex-1011	S. A. Nehmeh, Y. E. Erdi, C. C. Ling, K. E. Rosenzweig, O. D. Squire, L. E. Braban, E. Ford, K. Sidhu, G. S. Mageras, S. M. Larson, J. L. Humm. "Effect of respiratory gating on reducing lung motion artifacts in PET imaging of lung cancer." *Medical Physics*. 29 (3) (March 2002). https://doi.org/10.1118/1.1448824
Ex-1012	Woo, Sang-Keun, et al. "Development of a motion detecting system for respiratory-gated PET using laser optical displacement sensor." *2003 IEEE Nuclear Science Symposium. Conference Record* (IEEE Cat. No. 03CH37515). Vol. 3. IEEE, 2003. https://doi.org/10.1109/NSSMIC.2003.1352255

Ex-1013	Sadek A. Nehmeh, PhD, Yusuf E. Erdi, Clifton C. Ling, Kenneth E. Rosenzweig, Heiko Schoder, Steve M. Larson, Homer A. Macapinlac, Olivia D. Squire, and John L. Humm. "Effect of Respiratory Gating on Quantifying PET Images of Lung Cancer." *The Journal of Nuclear Medicine*, 43 (7) (July 2002) 876-881.
Ex-1014	Schöder, H., Erdi, Y.E., Larson, S.M. et al. "PET/CT: a new imaging technology in nuclear medicine." *European Journal of Nuclear Medicine and Molecular Imaging*, 30, 1419–1437 (2003). https://doi.org/10.1007/s00259-003-1299-6
Ex-1015	Osman, Medhat M., et al. "Respiratory motion artifacts on PET emission images obtained using CT attenuation correction on PET-CT." *European journal of nuclear medicine and molecular imaging* 30 (2003): 603-606. https://doi.org/10.1007/s00259-002-1024-x
Ex-1016	Beyer, Thomas, et al. "Dual-modality PET/CT imaging: the effect of respiratory motion on combined image quality in clinical oncology." *European journal of nuclear medicine and molecular*

	imaging 30 (2003): 588-596. https://doi.org/10.1007/s00259-002-1097-6
Ex-1017	Ritchie CJ, Hsieh J, Gard MF, et al: Predictive respiratory gating: A new method to reduce motion artifacts on CT scans. Radiology 190:847-852, 1994. https://doi.org/10.1148/radiology.190.3.8115638
Ex-1018	U.S. Patent Publication No. US 2006/0071932 A1 to Weese, et al. ("Weese-932")
Ex-1019	U.S. Patent No. 5,782,762 to Vining
Ex-1020	U.S. Patent Publication No. 2003/0004405 A1 to Townsend et al.
Ex-1021	Goerres, Gerhard W., et al. "PET-CT image co-registration in the thorax: influence of respiration." *European journal of nuclear medicine and molecular imaging* 29 (2002): 351-360, DOI 10.1007/s00259-001-0710-4
Ex-1022	Chen, George TY, Jong H. Kung, and Kevin P. Beaudette. "Artifacts in computed tomography scanning of moving objects."

	Seminars in radiation oncology. Vol. 14. No. 1. WB Saunders, 2004. https://doi.org/10.1053/j.semradonc.2003.10.004
Ex-1023	Kachelrieß, Marc, et al. "Kymogram detection and kymogram-correlated image reconstruction from subsecond spiral computed tomography scans of the heart." *Medical Physics*. 29.7 (2002): 1489-1503. https://doi.org/10.1118/1.1487861

[032] I reserve the right to supplement and amend any of my opinions in this declaration based on documents, testimony, and other information that becomes available to me after the date of this declaration.

V. LEGAL STANDARDS

[012] I am not a lawyer. My understanding of the legal standards that apply in reaching the conclusions of this declaration are based on discussions with counsel for Petitioner, my experience applying similar standards in other patent-related matters, and my reading of the documents submitted in this proceeding. In preparing this declaration, I have tried faithfully to apply these legal standards to the challenged claims.

[013] I have been informed that there are two ways in which prior art may render a patent claim unpatentable. First, I have been informed that the prior art can

"anticipate" a claim. Second, I have been informed that the prior art can render a claim "obvious" to a person of ordinary skill in the art. I understand that a claim is patentable if it was not anticipated and would not have been obvious by the prior art at the effective filing date of the patent.

[014] I have been informed that a dependent claim is a patent claim that refers to a previous patent claim. I have been informed that a dependent claim includes all the limitations of the claim to which it refers.

[015] I have been asked to provide my opinions as to whether the cited prior art teaches or renders obvious claims 1-18 of the '353 patent from the perspective of a person of ordinary skill in the art at the '353 patent's earliest claimed priority date of October 1, 2003, as described in more detail below.

[016] I have been informed that in inter partes review proceedings, such as this one, the party challenging the patent bears the burden of proving unpatentability by a preponderance of the evidence. I understand that a preponderance of the evidence means "more likely than not."

[017] For purposes of this declaration, I have been asked to provide my opinions on issues regarding unpatentability. I have been informed of the following legal standards, which I have applied in forming my opinions.

A. Level of Ordinary Skill in the Art

[018] I have been informed a person of ordinary skill in the art is determined by considering several factors, including the (i) type of problems encountered in the art; (ii) prior art solutions to those problems; (iii) rapidity with which innovations are made; (iv) sophistication of the technology; and (v) educational level of active workers in the field.

[019] I have been instructed to assume a person of ordinary skill in the art is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors discussed above.

B. Anticipation

[020] I have been informed that under 35 U.S.C. § 102, a patent claim is unpatentable for anticipation if the claimed subject matter was patented or described in a printed publication before the effective filing date of the claimed invention. I have been informed that a patent claim is anticipated under § 102 if a single prior art reference discloses all limitations of the claimed invention.

C. Obviousness

[021] I have been informed that, for obviousness under 35 U.S.C. § 103, a patent claim is unpatentable if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have

been obvious to a person having ordinary skill in the art to which said subject matter pertains at the time the invention was made.

[022] I have been informed that a proper obviousness analysis includes the following:

a. Determining the scope and content of the prior art;
b. Ascertaining the differences between the prior art and the claims at issue;
c. Resolving the level of ordinary skill in the pertinent art; and
d. Considering evidence of secondary indicia of non-obviousness (if available).

[023] I have been informed that the relevant time for considering whether a claim would have been obvious to a person of ordinary skill in the art is the time of invention. For my obviousness analysis, counsel for Petitioner instructed me to assume that the date of invention for the challenged claims is October 1, 2003. My opinions would not change if I assumed a later date of invention.

[024] I have been informed that a reference may be modified or combined with other references or with a person of ordinary skill in the art's own knowledge if the person would have found the modification or combination obvious. I have also been informed that a person of ordinary skill in the art is presumed to know all

the relevant prior art, and the obviousness analysis may consider the inferences and creative steps that a person of ordinary skill in the art would employ.

[025] I have been informed that whether a prior art reference renders a patent claim obvious is determined from the perspective of a person of ordinary skill in the art. I have also been informed that, while there is no requirement that the prior art contain an express suggestion to combine known elements to achieve the claimed invention, and while a suggestion to combine known elements to achieve the claimed invention may come from the prior art as a whole or individually and may consider the inferences and creative steps a person of ordinary skill in the art would employ, as filtered through the knowledge of one skilled in the art, obviousness grounds cannot be sustained by mere conclusory statements and must include some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

[026] In determining whether a prior art reference could have been combined with another prior art reference or other information known to a person having ordinary skill in the art, I have been informed that the following principles may be considered:

a. A combination of familiar elements according to known methods is likely to be obvious if it yields predictable results;

b. The substitution of one known element for another is likely to be obvious if it yields predictable results;

c. The use of a known technique to improve similar items or methods in the same way is likely to be obvious if it yields predictable results;

d. The application of a known technique to a prior art reference that is ready for improvement to yield predictable results;

e. Any need or problem known in the field and addressed by the reference can provide a reason for combining the elements in the manner claimed;

f. A person of ordinary skill often will be able to fit the teachings of multiple references together like a puzzle; and

g. The proper analysis of obviousness requires a determination of whether a person of ordinary skill in the art would have a "reasonable expectation of success"—but not "absolute predictability" of success—in achieving the claimed invention by combining prior art references.

[027] I have been informed that, when a work is available in one field, design alternatives and other market forces can prompt variations of it, either in the same field or in another. I have been informed that if a person of ordinary skill in the art

could have implemented a predictable variation and would have seen the benefit of doing so, that variation is likely to have been obvious. I have been informed that, in many fields, there may be little discussion of obvious combinations, and in these fields market demand—not scientific literature—may drive design trends. I have been informed that, when there was a design need or market pressure and there are a finite number of predictable solutions, a person of ordinary skill in the art would have had a good reason to pursue those known options.

[028] I have been informed that the law permits the application of "common sense" in examining whether a claimed invention would have been obvious to a person skilled in the art. For example, I have been informed that combining familiar elements according to known methods and in a predictable way may suggest obviousness when such a combination would yield nothing more than predictable results. I understand, however, that a claim is not obvious merely because every claim element is disclosed in the prior art and that a party asserting obviousness must still provide a specific motivation to combine or modify the references as recited in the claims and explain why one skilled in the art would have reasonably expected to succeed in doing so.

[029] I have been informed that there is no rigid rule that a reference or combination of references must contain a "teaching, suggestion, or motivation" to combine references. But I also understand that the "teaching, suggestion, or

motivation" test can be a useful guide in establishing a rationale for combining elements of the prior art. I have been informed that this test poses the question as to whether there is an express or implied teaching, suggestion, or motivation to combine prior art elements in a way that realizes the claimed invention, and that it seeks to counter impermissible hindsight analysis.

[030] I am not aware of any evidence of secondary considerations that would support a determination of non-obviousness of the claimed subject matter in the '353 patent.

[031] I have been informed that, in an obviousness analysis, prior art must be analogous prior art to the patent being considered. I have been informed that a prior art reference is considered to be analogous, or in the same field of art, if the reference is either (1) in the same field of endeavor as the challenged patent, regardless of the problems the challenged patent and the prior art address, or (2) reasonably pertinent to the particular problem being solved by the challenged patent.

VI. OVERVIEW OF THE '353 PATENT

A. Priority and Inventorship

[032] The application that issued as the '353 patent was filed on September 30, 2004. '353 patent, Cover. It claims priority to a foreign application in France, number 03 50631, filed October 1, 2003. *Id.* The patent issued on

September 11, 2012, with 18 claims, including independent claims 1 and 10. '353 patent, Cover, 8:1-10:28.

[033] For purposes of my analysis, I have been asked to assume that the relevant priority date is October 1, 2003. I understand that in a related litigation, the Patent Owner asserted a priority date of September 30, 2004, the date the earliest U.S. application was filed. My analysis herein does not change under either date. A POSITA would have found the claims obvious under either priority date.

[034] The patent lists two inventors, Stéphane Bonnet and Pierre Grangeat. The patent also lists known prior art books and articles with these inventors as authors from the field of medical imaging. Ex-1001, 1:18-20 ("Tomography" by P. Grangeat, Paris: Hermis Science Publications, 2002, SIBN 2.7562-0356-1 for "well-known computed tomography methods."), 3:39-44 (P. Grangeat, A. Koenig, T. Rodet and S. Bonnet in "Theoretical framework for a dynamic cone-beam reconstruction algorithm based on a dynamic particle model, Phys. Med. Biol. Vol. 47, No. 15, pp. 2 611-2625, August 2002 for "an attenuation technique.")

B. Purported Invention of the '353 Patent

[035] The '353 patent claims nothing more than combining two known imaging techniques and two known object motion measurement techniques using a known method of combination. Ex-1001, claims 1-18. The patent does not purport to invent any new techniques for imaging, motion measurement, or combining

images. And as I will explain, the claimed techniques alone and in combination were known and obvious as of the earliest claimed priority date of the '353 patent of October 1, 2003.

[036] The '353 patent professes to solve problems in medical imaging that arise due to the movement of living beings when attempting to combine images obtained with different modalities. Ex-1001, Abstract, 1:5-21. Motion artifacts and image combination were well-studied problems at the time. Indeed, the field was rich with methods to account for motion due to patient breathing or heartbeats, as the patent admits. Ex-1001, 1:35-60. And it was also already known to superimpose different types of medical images to help diagnose disease, as the patent likewise admits. *E.g.*, Ex-1001, 1:22-2:4 (describing known imaging methods for "simultaneously acquiring" CT and PET images), 2:21-48 (describing several known synchronization methods).

[037] The patent claims a method of forming an image in only a generalized, non-specific fashion that was unsophisticated for the time. Ex-1001, claims 1-18. The independent claims, for example, generally require forming an image of a mobile object using two different imaging techniques with corresponding, independent movement measurement techniques. Ex-1001, claims 1, 7, 12. According to the independent claims, the resulting image may be formed in any way so long as it is "based on": both imaging techniques, two independent "movement

measurements," and two movement states. Ex-1001, claims 1 and 12. The independent claims require no specific way to be "based on" these factors. *Id.*

[038] Indeed, the independent claims do not require temporally or spatially synchronizing the different imaging techniques and motion measurements. Temporal and spatial synchronization techniques only expressly appear in claims 2, 4, and 6, which depend from claim 1. No claims that depend from independent claim 12 recite ***any*** form of synchronization. And when synchronization does appear, the claims only require it in generalized, non-specific terms. Ex-1001, claims 2 ("time-synchronizing said first plurality of images and said second plurality of images to a common time scale based on the first and second movement states"), 4 ("spatially-synchronizing said first reconstructed images and said second reconstructed images"), 6 ("spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurement").

[039] The specification describes combining known "attenuative" methods—which measure "attenuation of radiation passing through [an] object"—with known "emissive" methods—which collect emitted "ionizing particles" after ingestion of radioactive liquid. *Id.* at 1:8-35. Attenuative methods can accurately show object composition and produce images the patent calls "anatomic" images. *Id.* at 1;21-30. Emissive methods can distinguish tissue types (e.g., healthy versus cancerous tissue)

and produce images the patent calls "functional" images. *Id.* The '353 patent recognizes that already-known "superposition" techniques for anatomic images and functional images facilitate medical diagnosis. *Id.*

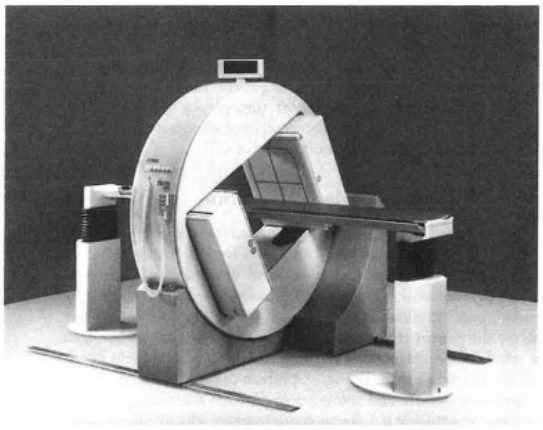
[040] The patent readily admits combinations of image modalities and motion correction techniques were not new. For example, the patent acknowledges an article on "a combined 3D PET/CT scanner" published in October 1998—***five*** full years before the claimed priority date of the '353 patent. *Id.* at 1:30-35. The patent further acknowledges object movement correction techniques were known to reduce image artifacts for attenuation images. *Id.* at 1:36-2:4. In fact, the patent only professes to advance the field by "apply[ing] such [known] image reconstruction method to emission techniques, with compensation of object movements." Ex-1001, 2:4-7.

[041] But, as I will show, the patent did not advance the field because the claimed methods and apparatuses were known and obvious.

VII. TECHNOLOGICAL BACKGROUND

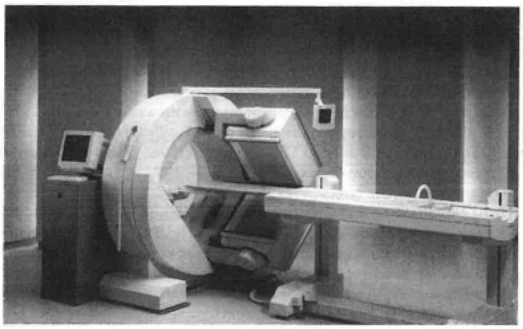
[042] Medical imaging from the time of the '353 patent generally involved collecting projections, such as from a radiation source. Ex-1008 (Bushberg textbook), 3-16. These techniques generally involved a patient gantry , radiation source (e.g., transmission or emission source), a detector network to measure projections, and an image processor (computer) for reconstructing images from

projections and transforming and combining images, as the patent acknowledges. Ex-1001, 1:8-20 (describing "well-known computed tomography measurements" and citing prior art textbook); Ex-1008, 3-16, 61-93; Weese, ¶ [0036] (image processor); Wainer, 8:38-9:20, Fig. 6; Ex-1011; Ex-1012; Ex-1013; Ex-1014; Ex-1015; Ex-1016; Ex-1017; Ex-1018, Ex-1019; Ex-1020.

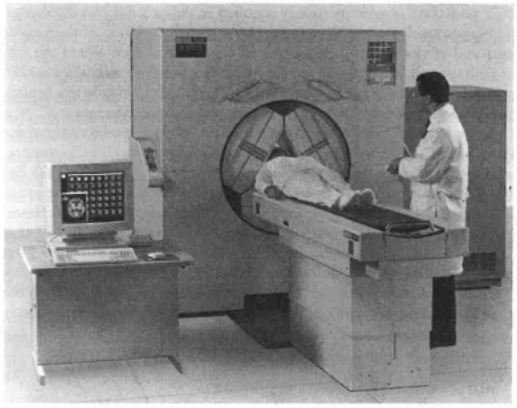


A

FIGURE 22-1. A: Double-head, fixed 180-degree (photograph courtesy of Marconi Medical Systems).



B



C

FIGURE 22-1 *(continued)*. (B) double-head, variable-angle (photograph courtesy of Siemens Medical Systems); **(C)** and triple-head (photograph courtesy of Trionix Research Laboratory, Inc.) single photon emission computed tomography (SPECT) systems. The double-head, variable-angle system is shown with the heads at a 76-degree angle for cardiac acquisition.

Ex-1008, 705 (Fig. 22-1)

[043] Some techniques, like Computerized Tomography (CT) and Some techniques, like Computerized Tomography (CT) and SPTCT (Single Photon

Transmission Computed Tomography),, pass external radiation through an object and form images based on the degree of attenuation within the object, as the ’353 patent describes. Ex-1001, 1:8-35 (discussing prior art attenuation methods); Ex-1008, 3-1, 61-93; Weese, ¶ [0036] (image processor); Wainer, 8:38-9:20, Fig. 6. These methods yield so-called structural images because they tend to show basic anatomy at high levels of detail, as the ’353 patent readily admits. Ex-1001, 1:21-34 (discussing “anatomic” images).

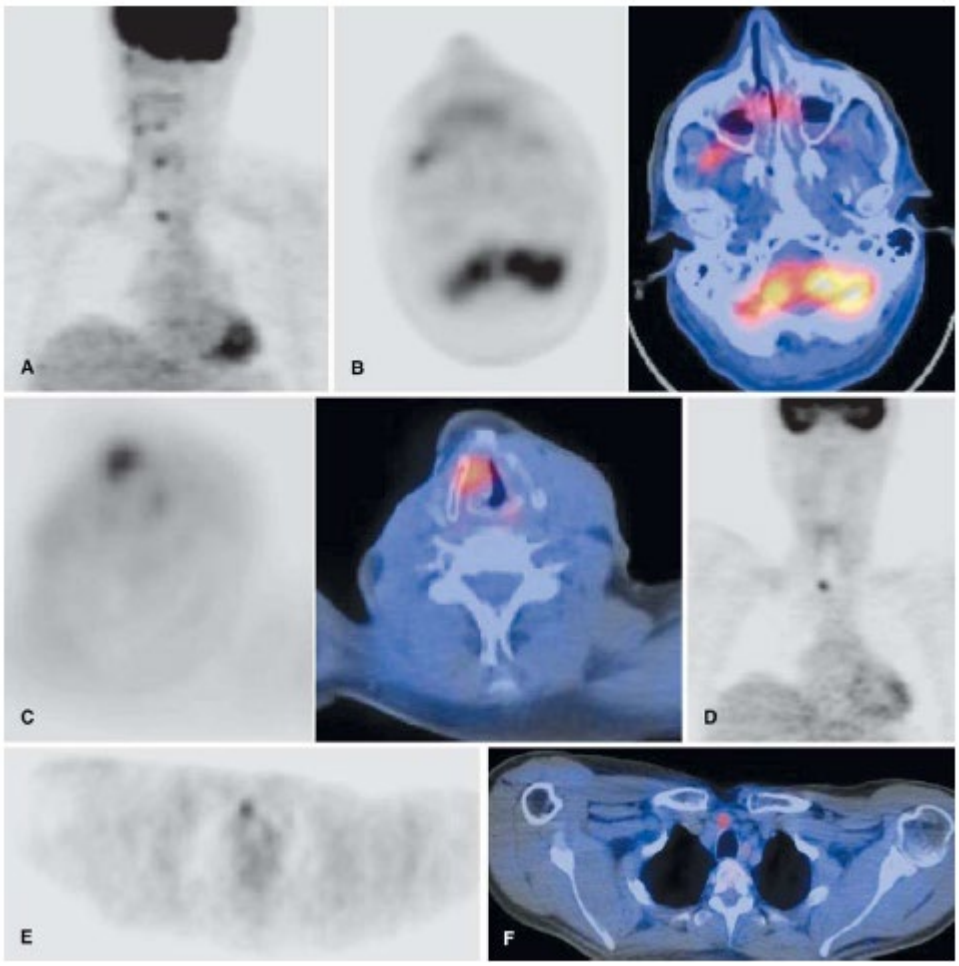
[044] In contrast, other techniques, like Positron Emission Tomograph (PET) and SPECT (Single Photon Emission Computed Tomography) detect radiation emitted from ingested radioactive substances, as the ’353 patent describes. Ex-1001, 1:8-35 (discussing prior art emission methods). These methods yield so-called functional images, because they strongly show certain types of soft tissues with increased metabolic activity, including certain organs or tumor, as the ’353 patent readily admits. Ex-1001, 1:21-34 (discussing prior art “functional” images). Functional images often weakly show structural features or even fail to show structure.

[045] While tomography generally collects information in slices, techniques for 3D images were known. For example, slice-by-slice volume rendering was a long-known technique. Muehllehner, Abstract (“slice-by-slice” PET approach), 1:65-2:14 (same), 12:48-60 (same), 13:18-38 (claim 1), Figs. 2, 2a, 11-13; Ex-1019,

Abstract, 2:18-33, 5:61-6:4, 6:11-25, 10:60-62, 16:62-67, Fig. 2; Ex-1020, ¶ [0081]; Ex-1008 (Bushberg textbook), 360-362. Visualization of "volume images" in the field often involved making volume images from planar slices. Ex-1018 ("Weese-932"), ¶ [0046]. Fig. 3a.

[046] Direct acquisition of 3D projections was also known. The Bushberg textbook from the time discusses 3D PET acquisition by removing septa from a detector system. Ex-1008, 725-27. There were known methods to reconstruct images directly as 3D images from projections. Ex-1020, ¶¶ [0027]-[0031] (providing overview papers providing known methods), [0077].

[047] At the time of the '353 patent, it was common to compare different images from different modalities because each modality provides different insights. Practitioners and researchers typically displayed different images side-by-side or superimposed images. Ex-1008 (Bushberg textbook), 86, 92-93, 735; Weese, ¶¶ [0019], [0060], [0076]; Wainer, 7:42-49; Ex-1009; Ex-1014, 1423 (Figs. 2A-F).



Ex-1014, 1423 (Fig. 2A-F) (showing PET/CT Fusion in color with PET images in grayscale)

And as the '353 patent further acknowledges, the "[p]rior art also includes devices for simultaneously acquiring both types of images"—attenuation and emission—including a known "combined 3D PET/CT scanner" that predates the patent by several years. Ex-1001, 1:33-35 (citing October 1998 paper).

[048] When comparing and combining images, it was commonly known that images need to be "registered" to common coordinates. Ex-1008 (Bushberg

textbook), 86 ("image co-registration" to superimpose images), 92-93 (same), 735 (registering to superimpose CT and PET); Weese, ¶ [0073] ("Registration is a generally known method of equalizing co-ordinate systems between two or more images with corresponding structures."); Wainer, 7:50-81 (overview of registration methods); Ex-1009 (registration to fuse PET/CT images); Ex-1021. Images taken on different instruments needed a common coordinate system. Weese, ¶¶ [0072]-[0075]; Wainer, 7:50-81; Ex-1009. And images taken at different timepoints needed to be registered to account for changes in patient alignment on the gantry. Wainer, 7:50-81. The '353 patent recognizes image registration was known and even states it "is not innovative" and the alleged "invention is not applicable to it." Ex-1001, 3:54-61.

[049] It was well known at the time that motion due to breathing and heartbeats create false distortions (artifacts) in images. Ex-1001, 1:36-2:3 (noting "[m]any studies have been carried out on [the problem of motion blurring] for several years, and several types of solutions have been suggested."); Ex-1008 (Bushberg textbook), 371, 451-53. Motion in CT and PET images was generally viewed as "unavoidable." Weese, ¶¶ [0002]-[0003]. One paper, for example, elegantly displayed that triangles, spheres, and pairs take on markedly different shapes in CT images with simulated breathing motion. Ex-1022, Abstract, Figs. 1-3.

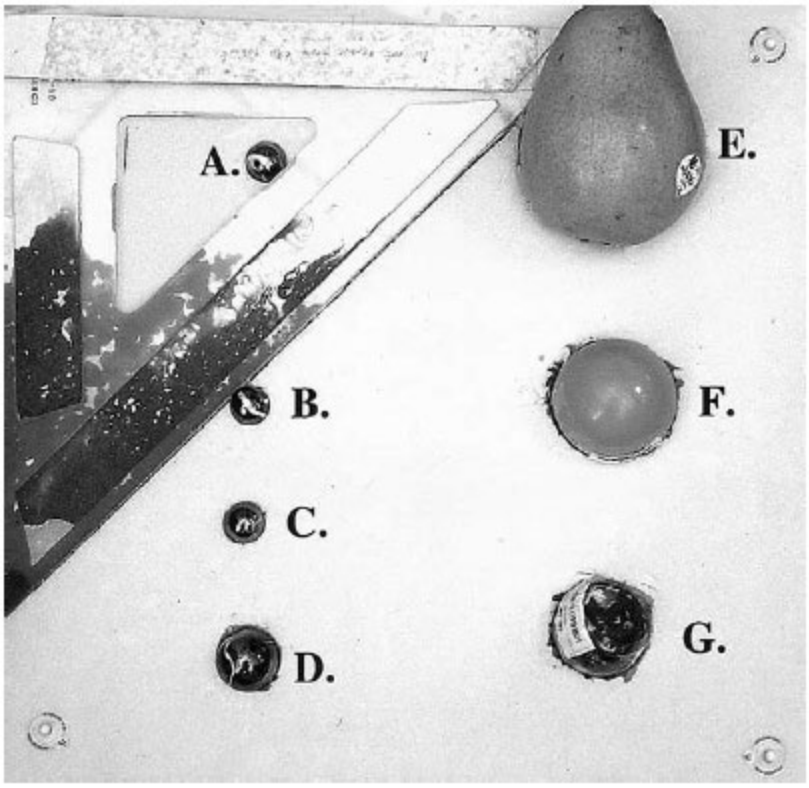


Figure 1. Photograph of the phantom of scanned geometric objects. Objects A through D are glass marbles. Object E is a pear (fruit) and objects F and G are rubber balls. A drafting triangle is shown in the upper left hand region of the Styrofoam block in which the objects are embedded. A rod attached to wheel drives the sled in an oscillatory motion with amplitude 1 cm and period of 4 seconds. The phase of the periodic motion is advanced by $\pi/4$ for each volumetric scan.

Ex-1022, Fig. 1

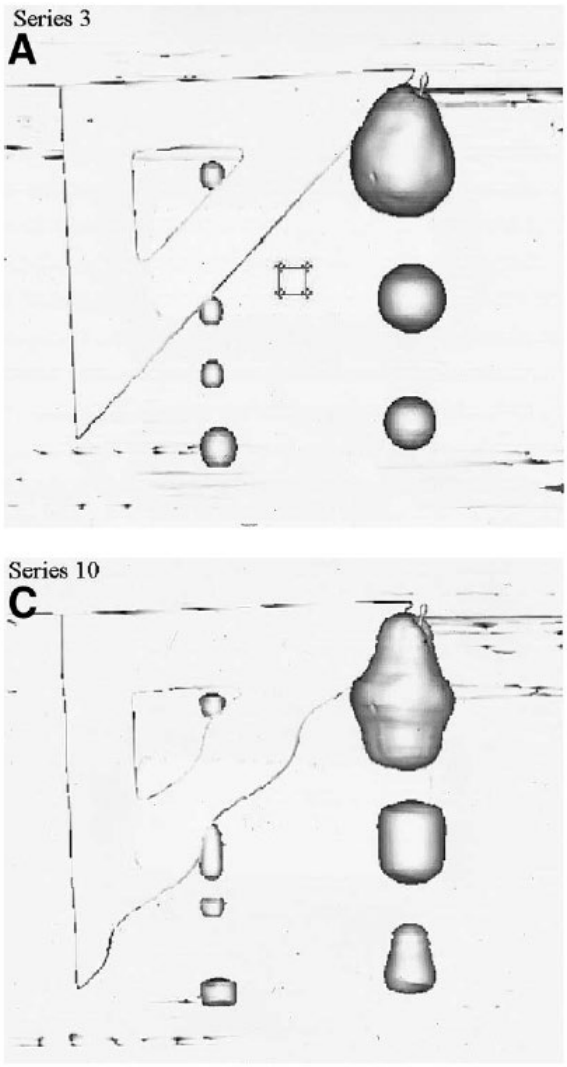


Figure 3. Three-dimensional surface rendered display of scanned objects. (A) Static—the objects appear in near-normal shape. There is minor partial volume sampling artifact of the 1.6 cm diameter marbles (objects A-C) when reconstructed with 0.375 cm slice thickness. (B) $\phi = \pi/4$: spheres A and C are highly elongated; sphere F is pear shaped, whereas sphere G is significantly shortened. The pear (E) now appears barrel shaped. (C) $\phi = 5\pi/4$: the pear is elongated; sphere F is barrel shaped; sphere G appears as a truncated cone.

Ex-1022, Fig. 3

[050] At the time of the ’353 patent, the field of medical imaging had developed many methods to account for motion artifacts arising due to patient breathing or heartbeats. The patent admits this. Ex-1001, 1:35-2:3. Some solutions relied on special breathing protocols or even holding breaths. *E.g.*, Ex-1016 (showing need for breathing protocols to reduce artifacts when merging PET and CT images). The ’353 patent describes prior art solutions to reduce blurring involving:

"taking the measurement as quickly as possible"; "making measurements only at an approximately invariant state"; and "digital correction" using "displacement fields." Ex-1001, 1:35-60.

[051] "Gating" images to the underlying motion provided another option to correct for motion, which was known for many years before the '353 patent. *E.g.*, Ex-1017 (1994 paper on gating CT data to account for motion). Image gating groups projections based on the phase of cyclic body rhythms. Gating relies on monitoring motion during data collection, typically using an independent sensor. A textbook from the time described the general approach to correct cardiac motion artifacts based on phase using sensor-based gating in nuclear medicine (e.g., PET). Ex-1008 (Bushberg textbook), 696-699. The figure below shows example images grouped based on the projection timing and the cardiac cycle as determined by an electrocardiogram sensor. Ex-1008, 698.

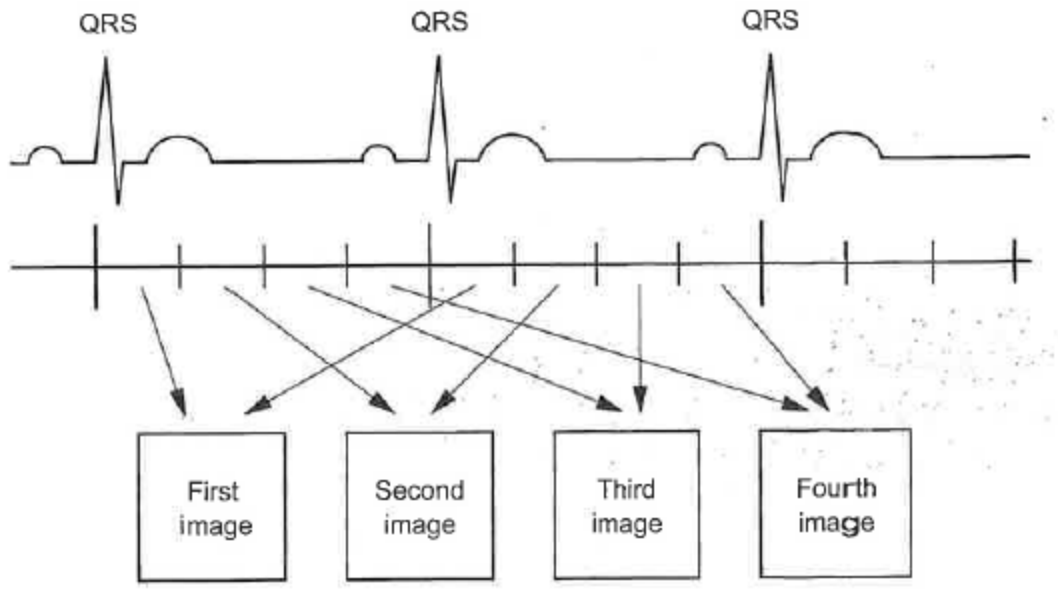


FIGURE 21-22. Acquisition of a gated cardiac image sequence. Only four images are shown here. Sixteen to 24 images are typically acquired.

Ex-1008, 698 (Figure 21-22) (grouping projections into different phases of cardiac cycle)

The patent also identifies a known prior art gating method that time-synchronizes reconstructions of CT images based on cardiac phase using a kymogram, which is a measure of heart motion based on a center-of-mass calculation from the CT image itself. Ex-1001, 3:21-26 (citing Ex-1023); Ex-1023.

[052] Gating was common in medical imaging. A 2003 article summarizing combined PET/CT technology mentions PET "gated image acquisition" in which PET "images can be recorded in synchrony with a physiological function," discussing cardiac and respiratory gating. Ex-1014, 1420. A 2002 paper described a similar approach to respiratory gating of PET images used on patients. Ex-1013.

That study employed camera data to group PET projections into different time bins corresponding to different phases of a respiratory cycle to reconstruct PET images for each phase. Ex-1013, 876 ("Methods" of abstract), 877 ("Data Acquisition" section). A similar study with overlapping authors used the same approach. Ex-1011, 367 (methods section). Another approach used a laser position to gate PET images. Ex-1012, 1923-24. And Wainer uses position sensor 31 and **displacement detector 32** for respiratory gating and a sensor 36 and **wave detector 37** for cardiac gating. Wainer, 9:6-20, Fig. 6.

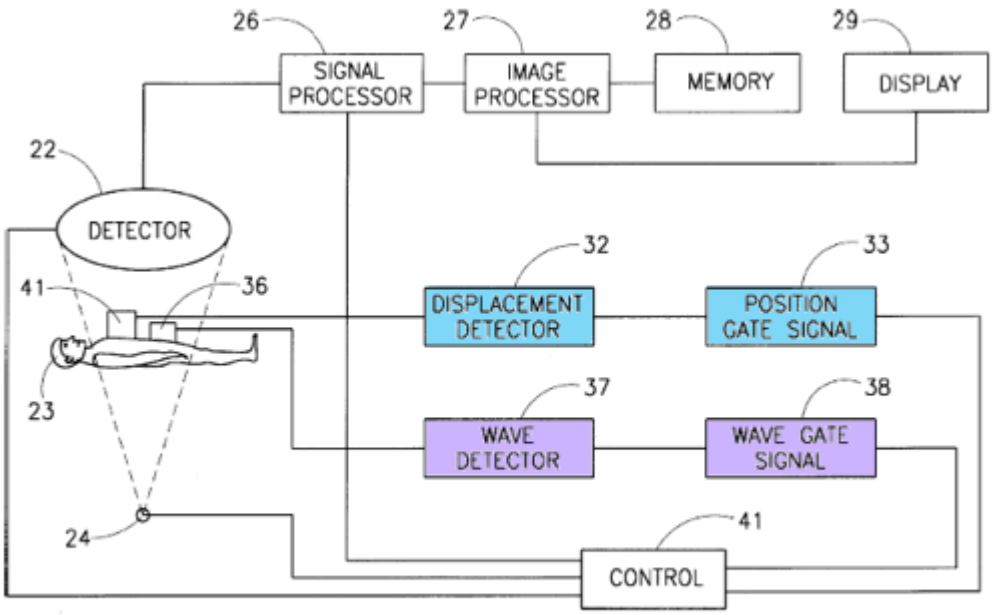


FIG.6

Wainer, Fig. 6 (annotated)

[053] As I will show, the known systems and methods I describe above teach every element of the claims of the '353 patent.

VIII. LEVEL OF ORDINARY SKILL

[054] In rendering the opinions set forth in this declaration, I have been asked to consider the ’353 patent claims and the prior art through the eyes of a person of ordinary skill in the art (which I may also refer to as “one skilled in the art,” “skilled artisan,” “POSITA,” “POSA,” an “ordinary artisan,” or similar variation). I have considered factors such as the educational level and years of experience of those working in the pertinent art, the types of problems encountered in the art, the teachings of the prior art, patents and publications of other persons or companies, and the sophistication of the technology.

[055] Taking the factors described in the Legal Standards – Level of Ordinary Skill in the Art section into consideration, it is my opinion that a person of ordinary skill in the art with respect to the ’353 patent would have possessed at least a four-year degree in physics, biophysics, medical physics, or a closely related field, and at least two years of experience in developing and/or applying computed tomography methods. Additional education could substitute for professional experience and vice versa.

[056] Based on my educational background and experience, I was at least a person of ordinary skill in the art at the earliest claimed priority date of the ’353 patent.

IX. CLAIM CONSTRUCTION

[057] I am not an attorney. However, I have been informed by counsel of certain legal standards that apply with respect to claim construction and indefiniteness, and I have used those standards, described below, in formulating my opinions.

[058] I have been instructed that the "intrinsic record" includes the patent itself, including the claims, description, and figures (Ex-1001), and the patent's prosecution history—i.e., the record of proceedings at the U.S. Patent and Trademark Office ("Patent Office") concerning the patent (Ex-1002). I understand that, like the claims and written description, the prosecution history provides evidence to a person of ordinary skill in the art of how the inventor intended his patent to be understood, and how the Patent Office understood the patent. I understand that the inventor is permitted to apply a special definition to the terms or to limit the scope of claim terms in his patent claims, which may differ from the term's plain and ordinary meaning. That special definition or limitation on scope may be provided in the patent's written description, the patent's prosecution history, or both.

[059] I understand that claim interpretation may also be informed by "extrinsic evidence" (that is, evidence outside of the patent record itself). I have been informed that extrinsic evidence may include dictionaries, technical treatises,

and other materials evidencing the meaning of a claim term and the understanding held by a person of ordinary skill in the relevant time period.

[060] I was also informed by counsel that the applicant of the ’353 patent can act as their own lexicographer, to set forth a definition of a claim term in the specification. The definition provided by the applicant can differ from the claim term’s plain and ordinary meaning. I have also been informed by counsel that when a patent claim uses the term “comprises” as a transitional statement after the preamble, there is a presumption that the claim is open-ended and not limited to the recited elements.

[061] Based on my review of the materials cited herein and my personal knowledge and experience, I have considered the plain and ordinary meaning of each term of the ’353 patent as it would have been understood by one skilled in the art at the earliest claimed priority date of the ’353 patent of October 1, 2003. I apply the plain and ordinary meaning of each claim term throughout this declaration.

[062] In addition, each of apparatus claims 12 through 18 recite the phrase “means for” for certain claim limitations. I understand that claims which recite “means for” presumptively invoke a means plus function interpretation under pre-AIA § 112, paragraph 6. As such, I understand that claim construction requires identifying a structure and its corresponding function for such terms.

A. Means-Plus-Function Terms

[063] As discussed above, I understand that there is a special category of claim terms, known as "means-plus-function" terms, that recite a structural component solely in terms of the function it performs. I understand that these terms recite functions but lack sufficient structure in the claims themselves, and that corresponding structure must be found in the specification as known to a person of ordinary skill in the art (or else the claim is indefinite). I have tried my best to identify a corresponding structure for each of the recited functions, to the extent they can be discerned from the '353 patent's specification. Because indefiniteness is not at issue in this proceeding, I express no opinion here about whether the structure identified below is sufficient for purposes of indefiniteness.

1. [12a-i]: "means for obtaining a plurality of first images of the mobile object using a first imaging technique"

[064] A POSITA would have understood that "means for obtaining a plurality of first images of the mobile object using a first imaging technique" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[065] Function: "obtaining a plurality of first images of the mobile object using a first imaging technique."

[066] Structure: The specification describes using known networks of detectors to obtain images, including detectors for attenuation or emission computed

tomography imaging techniques. Ex-1001, 1:4-35 (prior art "detector networks"), 1:41-45 (prior art "detectors"), 2:26-33 ("[k]nown installations").

[067] Such detectors, by themselves, are insufficient to obtain images. For example, the attenuation and emission medical imaging techniques discussed within the '353 patent require at least a radiation source, a gantry for placing a patient, and a computer processor and memory for reconstructing projections as images. § VII (TECHNOLOGICAL BACKGROUND). The patent does not disclose these additional features outside of a vague mention of an emissive radiation source. *E.g.*, Ex-1001, 2:42-52, 4:24-47.

[068] During prosecution, the applicant identified alleged support for this limitation at "Fig. 1, ref. Et1; Page 3, lines 24-25; Page 4, lines 24-28; Page 5, lines 16-17; and Page 18, lines 1-5," citing the as-filed specification and corrected figures submitted during prosecution. Ex-1002, 784. None of the cited disclosures connote specific structure for performing the claimed function. All address attenuation or emission techniques.

[069] Figure 1, "Et1" is a box stating to "Take measurement sets (attenuation)," which does not connote specific structure for performing the claimed function. Ex-1002, 244 (corrected Fig. 1); *see* Ex-1001, Fig. 1.

[070] The cited passages also do not connote a specific structure for performing the claimed function:

- "Images of the object are taken using an emission technique and an attenuation technique." Ex-1002, 22 (as-filed specification, page 3, lines 24-25); *see* Ex-1001, 2:8-9.
- "Although the invention is useful at the moment in the special context of acquisition pairs by attenuation and emission, it could be easily be generalized to include any pair of measurement acquisitions and is not limited to the embodiments described below." Ex-1002, 23 (as-filed specification, page 4, lines 24-28); *see* Ex-1001, 2:8-9.
- "Attenuation and emission measurements are made in steps Etl and Et2 in Figure 1." Ex-1002, 24 (as-filed specification, page 5, lines 16-17); *see* Ex-1001, 2:53-54.
- "Attenuation and emission techniques that could be used with the invention include CT (X-ray tomography) and MRI (nuclear magnetic resonance imagery) for attenuation, and SPECT (Single Photon Emission Computed Tomography) or TEP (position emission tomography) for emission." Ex-1002, 37 (as-filed specification page 18, lines 1-5); *see* Ex-1001, 7:54-58.

[071] Nevertheless, I have been asked to assume that a POSITA would have understood the structure corresponding to the function of obtaining a plurality of first images of the mobile object using a first imaging technique of [12a-i] includes an attenuation or emission radiation source and detector, gantry, processor, and

memory, consistent with known imaging techniques at the time of the '353 patent. *See supra* § VII.

2. [12a-ii]: "means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images,"

[072] A POSITA would have understood that "means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[073] Function: "obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images."

[074] Structure: The specification describes using sensors to measure object movement. Ex-1001, 2:59-62, 3:3-20, 3:54-58, 4:54-55, 5:15-16, 5:38-47, 8:59-62, Figs, 1-3, 6. The only examples it provides are "a breathing sensor, a pressure sensor or an electrocardiogram." Ex-1001, 2:59-62.

[075] Unlike claim 1, limitation [1a-ii], which specifically requires sensors, [12a-ii] does not specifically require sensors. But the patent does not disclose any corresponding structure capable of performing the claimed function.

[076] During prosecution, the applicant identified alleged support for [12a-ii] in conjunction with [12a-iii] at "Fig. 1, ref. Et11; Page 5, lines 20-26; and Page 6,

lines 6-13," citing the as-filed specification and corrected figures submitted during prosecution. Ex-1002, 784. All the cited disclosures describe sensors.

[077] Figure 1, "Et11" is a box stating, "Movement and/or position sensors in attenuation." Ex-1002, 244 (corrected Fig. 1); *see* Ex-1001, Fig. 1.

[078] The cited passages only describe sensors:

- "However, a time synchronization of measurement sets is usually necessary, within the two series and between the two series after step Et3. One useful method for achieving this may be to measure a patient movement using an independent sensor such as a breathing sensor, a pressure sensor or an electrocardiogram." Ex-1002, 24 (as-filed specification, page 5, lines 20-26); Ex-1001, 2:57-62.
- "Steps Et11 and Et12 in Figure 1 illustrate such uses of sensors. Movement or position sensors are usually suitable for this method. There may be an arbitrary number of these sensors. Some may be associated with the attenuation measurements and others with emission measurements. When a measurement set is taken, the associated sensors record the movement signal, etc., that they receive." Ex-1002, 25 (as-filed specification, page 6, lines 6-13); *see* Ex-1001, 3:3-9.

[079] In my opinion, a POSITA would have understood the means for obtaining a plurality of first measurements corresponding to movements of the

mobile object while obtaining the plurality of first images of [12a-ii] to include a breathing, pressure, or electrocardiogram sensor.

3. [12b]: "means for associating the plurality of first images with first movement states of the mobile object"

[080] A POSITA would have understood that "means for associating the plurality of first images with first movement states of the mobile object" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[081] Function: "associating the plurality of first images with first movement states of the mobile object."

[082] Structure: The specification describes no structure corresponding to the function of "associating the plurality of first images with first movement states of the mobile object." *See generally*, Ex-1001.

[083] During prosecution, the applicant identified alleged support for [12b] at "Fig. 1, ref. Et3; Fig. 2; Page 5, line 26 - page 6, line 5; Page 6, lines 13-16," citing the as-filed specification and corrected figures submitted during prosecution. Ex-1002, 785. None of the cited disclosures connote specific structure for performing the claimed function.

[084] Figure 1, "Et3" is a box vaguely stating "Time synchronization," which does not connote specific structure for performing the claimed function. Ex-1002, 244 (corrected Fig. 1); *see* Ex-1001, Fig. 1.

[085] Figure 2 is a time series plot that likewise does not describe any structure. Ex-1002, 10 (as-filed Fig. 1); *see* Ex-1001, Fig. 2.

[086] The cited passages also do not connote any specific structure for performing the claimed function:

- "Each measurement set is then associated with a determined state of the patient during which a measurement of his movement was made. If this measurement relates to a cyclic phenomenon such as breathing, the measurement sets may be associated with time phases of this movement as suggested in the diagram in Figure 2, in which six measurement sets M1 to M6 taken over a breathing cycle are associated with average phases as φ_1 to φ_6." Ex-1002, 24-25 (as-filed specification, page 5, line 26 - page 6, line 5); *see* Ex-1001, 2:62-3:2.
- "When all measurement sets have been taken, comparisons between signals recorded by the different sensors may be used to place the two measurement sets at determined locations on a common time scale." Ex-1002, 25 (as-filed specification, page 6, lines 13-16); Ex-1001, 3:9-13.

[087] I have been asked to assume the corresponding structure includes a computer programmed to perform the associating.

4. [12c-i]: "means for obtaining a plurality of second images of the mobile object using a second imaging technique"

[088] A POSITA would have understood that "means for obtaining a plurality of second images of the mobile object using a second imaging technique" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[089] Function: "obtaining a plurality of second images of the mobile object using a second imaging technique."

[090] Structure: The specification describes using known networks of detectors to obtain images, including detectors for attenuation or emission computed tomography imaging techniques. Ex-1001, 1:4-35 (prior art "detector networks"), 1:41-45 (prior art "detectors"), 2:26-33 ("[k]nown installations").

[091] Such detectors, by themselves, are insufficient to obtain images. For example, the attenuation and emission medical imaging techniques discussed within the '353 patent require at least a radiation source, a gantry for placing a patient, and a computer processor and memory for reconstructing projections as images. § VII (TECHNOLOGICAL BACKGROUND). The patent does not disclose these additional features outside of a vague mention of an emissive radiation source. *E.g.*, Ex-1001, 2:42-52, 4:24-47.

[092] During prosecution, the applicant identified alleged support for this limitation at "Fig. 1, ref. Et2; Page 3, lines 24-25; Page 4, lines 24-28; Page 5, lines

16-17; and Page 18, lines 1-5," citing the as-filed and corrected figures submitted during prosecution figures. Ex-1002, 784. None of the cited disclosures connote specific structure for performing the claimed function.

[093] Figure 1, "Et2" is a box stating to "Take measurement sets (emission)," which does not connote specific structure for performing the claimed function. Ex-1002, 244 (corrected Fig. 1); *see* Ex-1001, Fig. 1.

[094] The cited passages also do not connote a specific structure for performing the claimed function:

- "Images of the object are taken using an emission technique and an attenuation technique." Ex-1002, 22 (as-filed specification, page 3, lines 24-25); *see* Ex-1001, 2:8-9.
- "Although the invention is useful at the moment in the special context of acquisition pairs by attenuation and emission, it could be easily be generalized to include any pair of measurement acquisitions and is not limited to the embodiments described below." Ex-1002, 23 (as-filed specification, page 4, lines 24-28); *see* Ex-1001, 2:8-9.
- "Attenuation and emission measurements are made in steps Etl and Et2 in Figure 1." Ex-1002, 24 (as-filed specification, page 5, lines 16-17); *see* Ex-1001, 2:53-54.

- "Attenuation and emission techniques that could be used with the invention include CT (X-ray tomography) and MRI (nuclear magnetic resonance imagery) for attenuation, and SPECT (Single Photon Emission Computed Tomography) or TEP (position emission tomography) for emission." Ex-1002, 37 (as-filed specification page 18, lines 1-5); *see* Ex-1001, 7:54-58.

[095] Nevertheless, I have been asked to assume that a POSITA would have understood the corresponding structure to the function of obtaining a plurality of first images of the mobile object using a first imaging technique of [12c-i] to include an attenuation or emission radiation source and detector, gantry, processor, and memory, consistent with known imaging techniques at the time of the '353 patent. *See supra* § VII.

5. [12c-ii]: "means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images"

[096] A POSITA would have understood that "means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[097] Function: "obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images."

[098] Structure: The specification describes using sensors to measure object movement. Ex-1001, 2:59-62, 3:3-20, 3:54-58, 4:54-55, 5:15-16, 5:38-47, 8:59-62," Figs, 1-3, 6. It provided examples such as "a breathing sensor, a pressure sensor or an electrocardiogram." Ex-1001, 2:59-62.

[099] Unlike claim 1, limitation [1c-ii], which specifically requires sensors, [12c-ii] does not specifically require sensors. But the patent does not disclose any other corresponding structure capable of performing the claimed function.

[100] During prosecution, the applicant identified alleged support for [12c-ii] in conjunction with [12c-iii] at "Fig. 1, ref. Et12; Page 5, lines 20-26; and Page 6, lines 6-13," citing the as-filed specification and corrected figures submitted during prosecution. Ex-1002, 785. All the cited disclosures describe sensors.

[101] Figure 1, "Et12" is a box stating, "Movement and/or position sensors in attenuation." Ex-1002, 244 (corrected Fig. 1); *see* Ex-1001, Fig. 1.

[102] The cited passages only describe sensors:

- "However, a time synchronization of measurement sets is usually necessary, within the two series and between the two series after step Et3. One useful method for achieving this may be to measure a patient movement using an independent sensor such as a breathing sensor, a pressure sensor or an electrocardiogram." Ex-1002, 24 (as-filed specification, page 5, lines 20-26); Ex-1001, 2:57-62.

- "Steps Et11 and Et12 in Figure 1 illustrate such uses of sensors. Movement or position sensors are usually suitable for this method. There may be an arbitrary number of these sensors. Some may be associated with the attenuation measurements and others with emission measurements. When a measurement set is taken, the associated sensors record the movement signal, etc., that they receive." Ex-1002, 25 (as-filed specification, page 6, lines 6-13); *see* Ex-1001, 3:3-9.

[103] In my opinion, a POSITA would have understood the structure corresponding to the function of obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images of [12c-ii] to include a breathing, pressure, or electrocardiogram sensor.

6. [12d]: "means for associating the plurality of second images with second movement states of the mobile object"

[104] A POSITA would have understood that "means for associating the plurality of second images with second movement states of the mobile object" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[105] Function: "associating the plurality of second images with second movement states of the mobile object."

[106] Structure: The specification describes no structure corresponding to the function of "associating the plurality of second images with second movement states of the mobile object." *See generally*, Ex-1001.

[107] The full limitation [12d] recites "*means for associating the plurality of second images with second movement states of the mobile object*, the second movement states being determined by the second measurements." During prosecution, the applicant identified alleged support for a similar limitation, "*means for associating the plurality of second images with second movement states of the mobile object* using the first measurements," which is the same as [12d] for the italicized portion: Ex-1002, 785. I understand that the applicant characterized these differences as non-substantive and as arising from a typographical error in an earlier claim amendment. Ex-1002, 832 (amendment after allowance identifying March 8, 2011 amendment as correct language, with typo introduced by September 27, 2011 amendment), 842 (amendment with claim language as eventually issued); *see* Ex-1002, 675-76 (March 8, 2011 amendment), 734 (September 27, 2011 amendment).

[108] The applicant cited "Fig. 1, ref. Et3; Fig. 2; Page 5, line 26 - page 6, line 5; Page 6, lines 13-16" in the as-filed specification and corrected figures submitted during prosecution as alleged support for "*means for associating the plurality of second images with second movement states of the mobile object* using

the first measurements." Ex-1002, 785. None of the cited disclosures connote specific structure for performing the claimed function.

[109] Figure 1, "Et3" is a box stating "Time synchronization," which does not connote specific structure for performing the claimed function. Ex-1002, 244 (corrected Fig. 1); *see* Ex-1001, Fig. 1.

[110] Figure 2 is a time series plot that likewise does not describe any structure. Ex-1002, 10 (as-filed Fig. 2); *see* Ex-1001, Fig. 2.

[111] The cited passages also do not connote any specific structure for performing the claimed function:

- "Each measurement set is then associated with a determined state of the patient during which a measurement of his movement was made. If this measurement relates to a cyclic phenomenon such as breathing, the measurement sets may be associated with time phases of this movement as suggested in the diagram in Figure 2, in which six measurement sets M1 to M6 taken over a breathing cycle are associated with average phases as φ_1 to φ_6." Ex-1002, 24-25 (as-filed specification, page 5, line 26 - page 6, line 5); *see* Ex-1001, 2:62-3:2.
- "When all measurement sets have been taken, comparisons between signals recorded by the different sensors may be used to place the two measurement

sets at determined locations on a common time scale." Ex-1002, 25 (as-filed specification, page 6, lines 13-16); Ex-1001, 3:9-13.

[112] I have been asked to assume the corresponding structure includes a computer programmed to perform the associating..

7. [12e]: "means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,"

[113] A POSITA would have understood that "means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[114] Function: "forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states."

[115] Structure: The specification describes no structure corresponding to the function of "forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement

states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states." *See generally*, Ex-1001.

[116] During prosecution, the applicant identified alleged support for this limitation at "Fig. 1, refs. Et6, Et7, Et8, Et9, Et10, Et17, Et18; Page 7, lines 3-17; Page 8, line 6 - page 11, line 2; Page 11, line 26 - page 17, line 28," citing the as-filed and corrected figures submitted during prosecution figures. Ex-1002, 785. None of the cited disclosures connote specific structure for performing the claimed function.

[117] Figure 1, "Et 6" is a box stating "Spatial synchronization," "Et 7" and "ET 8" are boxes stating "Displacement fields between states on images," "ET 9" is a box stating "Enhanced displacement fields," Et 10" is a box stating "Reconstruction of a complete emission image," and "Et 17" are boxes that each state "Displacement fields between states on measurements." Ex-1002, 244 (corrected Fig. 1); *see* Ex-1001, Fig. 1. None of these boxes connote specific structure for performing the claimed function.

[118] The cited passages also do not connote any specific structure for performing the claimed function:

- "After these measurement set collection and time synchronisation steps Et1, Et2, and Et3, at least a partial image reconstruction is carried out for the patient by multiple states in steps Et4 and Et5 for each measurement

technique. This means that each measurement set such as M1 is used to give a particular image assuming that the patient is motionless throughout the time that the measurement sets are being taken. Conventional digital means such as filtering and back projection are applied. The partial images thus obtained are usually based on data that are too incomplete to be precise, but in any case they are sufficiently detailed so that they can be compared with each other to determine the patient's movements between two phases. For further information, refer to the previous state of the art." Ex-1002, 26 (as-filed specification, page 7, lines 3-17 (line 17 cuts sentence cut off)); *see* Ex-1001, 3:7-39.

- The cited passages describe spatial synchronization and provides mathematical formulas, mentioning sensors. Ex-1002, 26-30 (as filed specification, page 8, line 6 - page 11, line 2); *see* Ex-1001, 3:54-4:60.
- The cited passages describe displacement field calculation using sensor measurements and provide mathematical formulas. Ex-1002, 30-36 (as filed specification, page 11, line 26 - page 17, line 28); *see* Ex-1001, 5:15-7:48.

[119] I have been asked to assume the corresponding structure includes a computer programmed to perform the forming..

8. Claim 13: "means for forming first reconstructed images corresponding to said plurality of first images and second

reconstructed images corresponding to said plurality of second images."

[120] A POSITA would have understood that "means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[121] Function: "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images."

[122] Structure: The specification describes no structure corresponding to the function of "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images." *See generally*, Ex-1001. For example, the patent mentions image reconstruction methods without discussing any corresponding structure. *E.g.*, Ex-1001, 1:61-2:7, 3:21-48, 7:24-48.

[123] I have been asked to assume the corresponding structure includes a computer programmed to perform the forming.

9. Claim 15: "means for forming displacement fields corresponding, respectively, to said plurality of first images,

said plurality of first measurements, said plurality of second images, and said plurality of second measurements."

[124] A POSITA would have understood that "means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[125] Function: "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements."

[126] Structure: The specification describes no structure corresponding to the function of "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements." *See generally*, Ex-1001. For example, the patent describes displacement fields without discussing any corresponding structure for forming those fields. *E.g.*, Ex-1001, 5:15-7:48.

[127] I have been asked to assume the corresponding structure includes a computer programmed for forming displacement fields.

10. Claim 16: "means for combining said displacement fields"

[128] A POSITA would have understood that "means for combining said displacement fields" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[129] Function: "combining said displacement fields."

[130] Structure: The specification describes no structure corresponding to the function of "combining said displacement fields." *See generally*, Ex-1001. For example, the patent describes displacement fields without discussing any corresponding structure for combining those fields. *E.g.*, Ex-1001, 5:15-7:48.

[131] I have been asked to assume the corresponding structure includes a computer programmed for combining displacement fields.

11. Claim 17: "means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields."

[132] A POSITA would have understood that "means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields" invokes pre-AIA § 112, ¶ 6 as a means-plus-function term.

[133] Function: "estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields."

[134] Structure: The specification describes no structure corresponding to the function of "estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields." *See generally*, Ex-1001. For example, the patent describes displacement fields and estimating object movement without discussing any corresponding structure. *E.g.*, Ex-1001, 5:15-7:48.

[135] I have been asked to assume the corresponding structure includes a computer programmed for estimating movement based on images and measurements.

X. THE PRIOR ART

[136] In forming my opinions, I assessed the following prior art when considering whether the claims of the '353 patent would have been obvious to a person of ordinary skill in the art:

- Ex-1005, U.S. Patent Publication No. 2005/0226527 to Weese et al. ("Weese");
- Ex-1006, U.S. Patent No. 5,744,802 to Muehllehner et al. ("Muehllehner"); and
- Ex-1007, U.S. Patent No. 5,871,013 to Wainer et al. ("Wainer").

[137] None of these references were cited during prosecution or considered by the Examiner. Ex-1002; Ex-1001, Cover. Based on my review, Weese, Muehllener, and Wainer are not cumulative of the prior art considered during prosecution because the grounds presented herein teach the claim features the Examiner identified in the statement of reasons for allowance. Ex-1002, 810 (Examiner's reasons for allowance).

A. Overview of Weese (U.S. 2005/0226527)

1. Weese is Prior Art

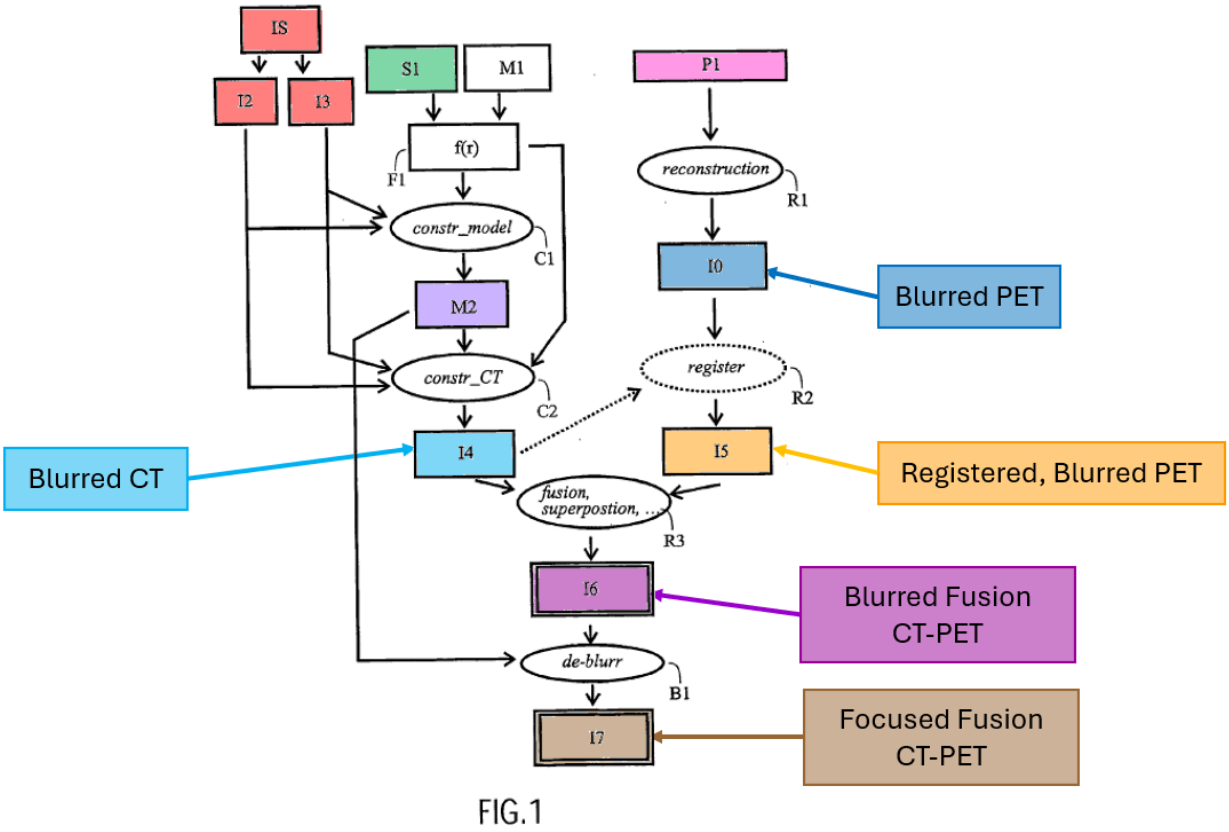
[138] Weese is a U.S. Patent Application that published October 13, 2005, directed to correcting motion artifacts in tomography (e.g., CT or PET images). Weese, Cover, Abstract, ¶¶ [0001]-[0004]. I understand that Weese is a publication of a National Stage entry of PCT Application PCT/IB03/03011 filed July 8, 2003 (which designated the United States and published in English) and that Weese is accordingly a prior art reference under pre-AIA 35 U.S.C. § 102(e)(1).

2. Weese Flexibly Describes Many Ways to Combine CT and PET Images to Correct Motion Artifacts

[139] Weese discloses several approaches to the problem of motion artifacts when combining images of moving objects generated by two systems, including combining CT and PET images. *E.g.*, Weese, Abstract, Figs. 1-3. Weese identifies that respiration during long PET acquisition times, for example, creates motion

artifacts that "manifest as an unsharp and blurred image of the object." Weese, ¶ [0049]. But Weese's techniques apply to motion "in a very broad sense" and encompass heartbeats and/or breathing. *E.g.*, Weese, ¶¶ [0009], [0049], [0062], Figs. 4-5. Weese also discloses ways to combine images using different setups—including using a combination CT/PET apparatus (e.g., Fig. 6) or using independent CT and PET systems that are not co-located (e.g., Weese, ¶¶ [0072]-[0074], [0080]).

[140] Weese's Figures 1 through 3 give example methods to address motion artifacts. I will first describe these examples, but as I will later explain, Weese promotes flexibility and expressly discloses using aspects of these embodiments interchangeably. I begin with Figure 1, which I annotate and show here:



Weese, Fig. 1 (annotated)

[141] Considering respiratory motion as an example, Figure 1 generally involves:

i. generating **CT images I2** and **I3** at different motion states (e.g., full inhale / full exhale), which may be instantaneously collected or extracted from an image sequence **IS** taken over the breathing cycle (Weese, ¶¶ [0052], [0062]);

ii. constructing **object motion model M2**, which may be based on a "motion signal" determined from **sensor S1** that describes the "actual motion process" of respiration (Weese, ¶¶ [0062]-[0067]);

iii. reconstructing **PET image I0** from **projections P1** using standard techniques, where **I0** is also blurred from respiration during long exposure times (Weese, ¶¶ [0048]-[0051]);

iv. when CT and PET systems are separate and independent (i.e., not co-located), creating **registered, blurred PET image I5** by registering **I0** to CT coordinates (Weese, ¶¶ [0072]-[0075]; *see* Weese, ¶¶ [0003], [0032], [0080], claims 6, 8; Ex-1009 (2001 paper cited by Weese at ¶¶ [0003], [0074] as a suitable registration technique)).

v. using **motion model M2** to create **blurred CT image I4** over the breathing cycle, which represents a weighted "superposition of all states of motion" (Weese, ¶¶ [0068]-[0069]);

vi. combining **blurred CT image I4** with **blurred PET image I5** (or **I0**) to create a **blurred combination CT-PET image I6** (Weese, ¶¶ [0075]-[0076]); and

vii. using **motion model M2** to generate **focused PET-CT image I7** on a particular motion state (e.g., full inhale) from **I6** (Weese, ¶ [0077]).

[142] I note that Figure 1 applies to respiratory motion but may additionally or alternatively address other types of motion (e.g., beating hearts). Weese, ¶¶ [0009], [0047].

[143] Next, Figure 2 involves the same CT images **I2** and **I3**, **sensor S1**, **motion model M2**, **projections P1**, and **PET image I0** as Figure 1. Weese, ¶¶ [0078]-[0080]. But instead of combining ***blurred*** CT image **I4** with a ***blurred*** PET image, as in Figure 1, the method of Figure 2 involves first ***focusing*** the PET image, and then combining it with an ***already-focused*** CT image. Weese, ¶¶ [0078]-[0080]. For Figure 2, Weese describes:

i. using **motion model M2** to focus **blurred PET image I0** and generate **focused PET image I8** (Weese, ¶¶ [0078]-[0079]); and

ii. combining one of **CT images I2** or **I3** with **focused PET image I8** to generate **focused PET-CT image I9** at a particular motion state (e.g., full inhale or exhale) (Weese, ¶¶ [0078]-[0079]).

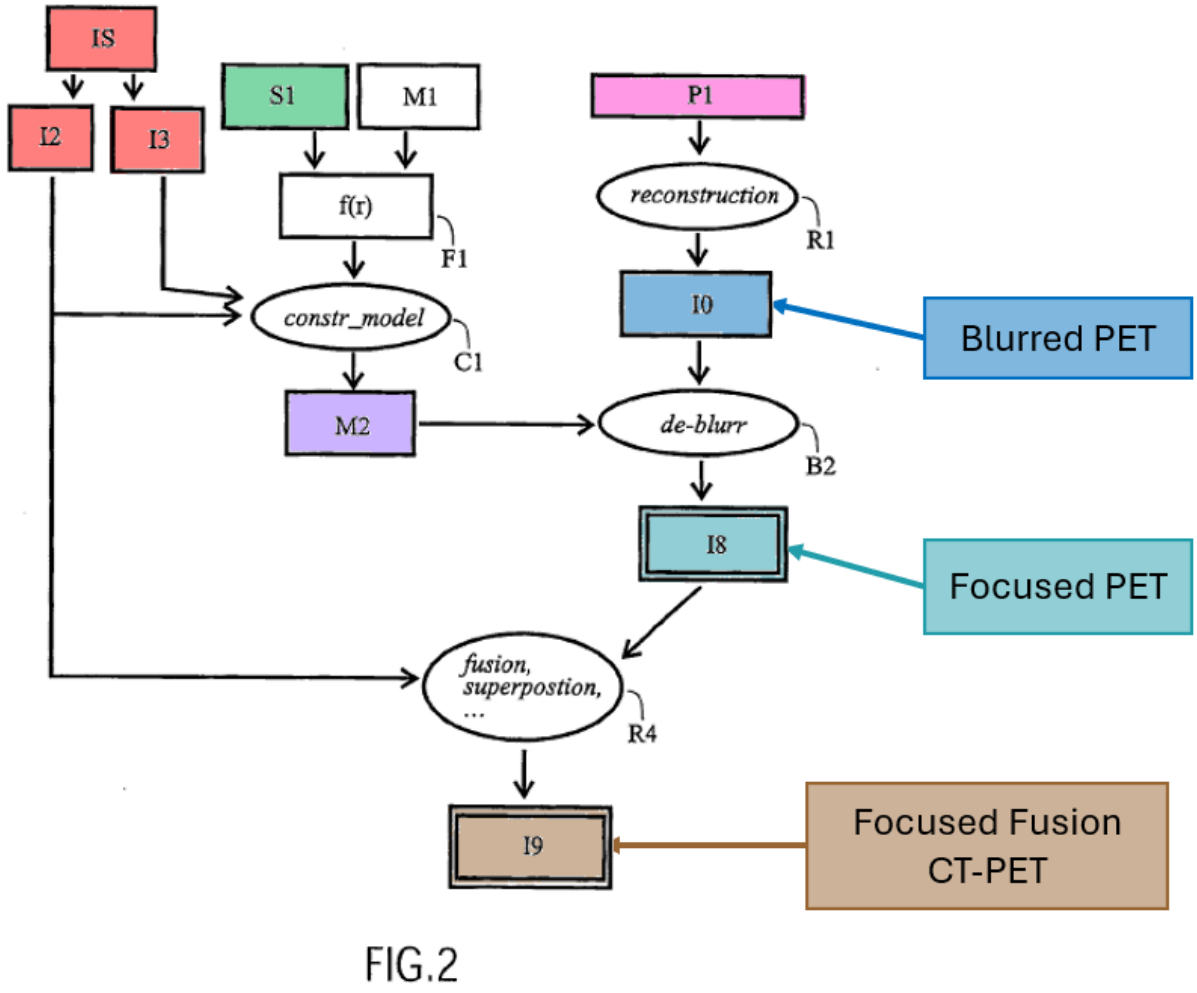


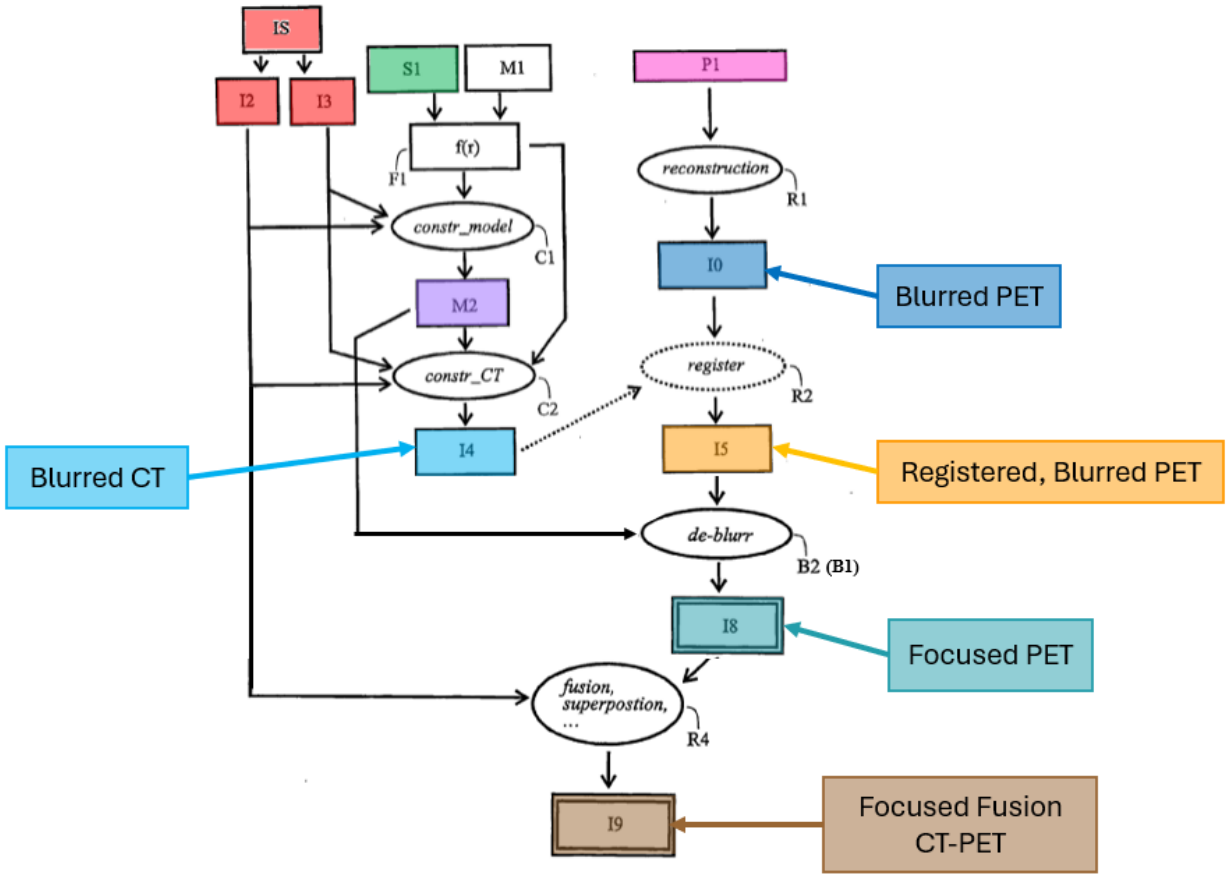
FIG.2

Weese, Fig. 2 (annotated)

[144] Weese further discloses an "alternative for the method of Figure 2 (not shown)," which applies when "coordinate systems of the image **I0** and the images **I2** and **I3** are different," i.e., for separate, independent CT and PET systems. Weese, ¶ [0080] (colors added). This variation registers image **I0** to create **registered, blurred PET image I5**, which has coordinates that "correspond[] to that of the image **I4** and hence to that of the motion model **M2**," just like in Figure 1. *Id.* (colors

added); *see* Weese, ¶¶ [0003], [0032], [0077]-[0075], [0080], claims 6, 8, Fig. 1; *see* Ex-1009 (2001 paper cited by Weese at ¶¶ [0003], [0074] as a suitable registration technique). But unlike Figure 1, this variation performs focusing step B1 (or B2) on **I5** to generate a **focused PET image**, which is the approach of Figure 2. *Id.* This alternative concludes by creating a **focused PET-CT image** by combining the **focused PET image** with the corresponding CT image **I2** or **I3**. Weese, ¶¶ [0078]-[0080], Fig. 2. Thus, for this variation, Weese adds registration step R2 and associated steps to the method of Figure 2. Weese, ¶¶ [0072]-[0075], [0080].

[145] I illustrate this variation below using an annotated combination of Figures 1 and 2.



Weese, modified Figs. 1-2 (annotated)

[146] Finally, Figure 3 involves the same CT images **I2** and **I3**, **sensor S1**, **motion model M2**, **projections P1**, and **blurred CT image I4** as Figure 1. Weese, ¶¶ [0081]-[0082]. But here, Weese teaches using **I4** to reconstruct the blurred PET image **I10**. Weese, ¶ [0083]. Weese describes **I10** as a "qualitatively enhanced image" because it uses attenuation information from **I4**, which contains the same motion artifacts as the PET image. *Id*. Weese explains this method better accounts for motion artifacts that arise from variations in attenuation due to changes in the "relative location of the origin of the X-ray quanta due to the respiratory motion."

Weese, ¶¶ [0047]-[0051], [0082] (referencing "cause 2" of paragraph [0051]). Weese states "[t]he method of Fig. 3 can be combined at will with the methods of Fig. 1 and Fig. 2" when using a combination PET-CT system. Weese, ¶ [0084].

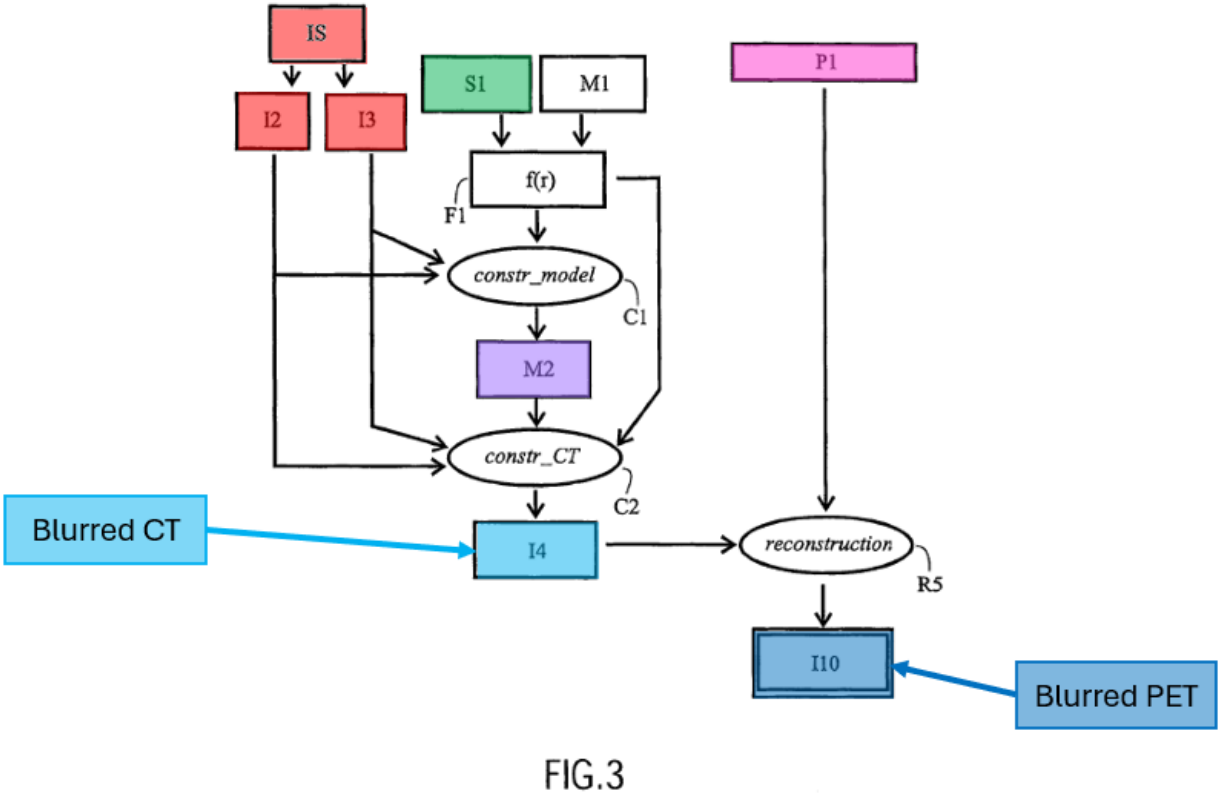


FIG.3

Weese, Fig. 3 (annotated)

[147] Weese promotes a flexible approach to correcting motion artifacts and combining CT and PET that is not limited to the specific examples shown in Figures 1-3. For example, Weese summarizes its alleged invention as acquiring images using two methods, then forming a motion model that is flexibly "implemented in a different manner in image processing or image forming steps, so that the information contents of either the first image or a combination image . . . is

enhanced." Weese, Abstract. Weese teaches using motion data "in various ways in supplementary image processing or image forming steps, resulting in a higher quality of the resultant images."). Weese, ¶ [0013].

[148] Weese explains its approaches can be used interchangeably and in combination. Weese, ¶¶ [0018]-[0019], [0029] (combining claims 1 and 3 or claims 2 and 3), [0080] (combining aspects of Figs. 1-2), [0084] (combining aspects of Figs. 1-3), Figs. 1-3 (containing features common to all three figures). Weese notes "[t]he method of FIG. 3 can be combined ***at will*** with the methods of FIG. 1 and FIG. 2." Weese, ¶ [0084] (emphasis added). And Weese explains "[g]enerally speaking, the methods of the FIGS. 1, 2, and 3 can also be simultaneously used in a system so as to enable presentation of the various results of the methods to a viewer." Weese, ¶ [0084].

[149] Weese explains the value of using multiple image correction and fusion methods. Physicians would have "desire[d]" various views of combination images "to enable comparison or a combination of information [in an unaltered image] with information from other [motion corrected] images," for example. Weese, ¶ [0075]. Using different methods furthers Weese's overall goal "to increase the information content of images containing motion artifacts." Weese, ¶ [0004].

B. Overview of Muehllehner (U.S. Patent No. 5,744,802)

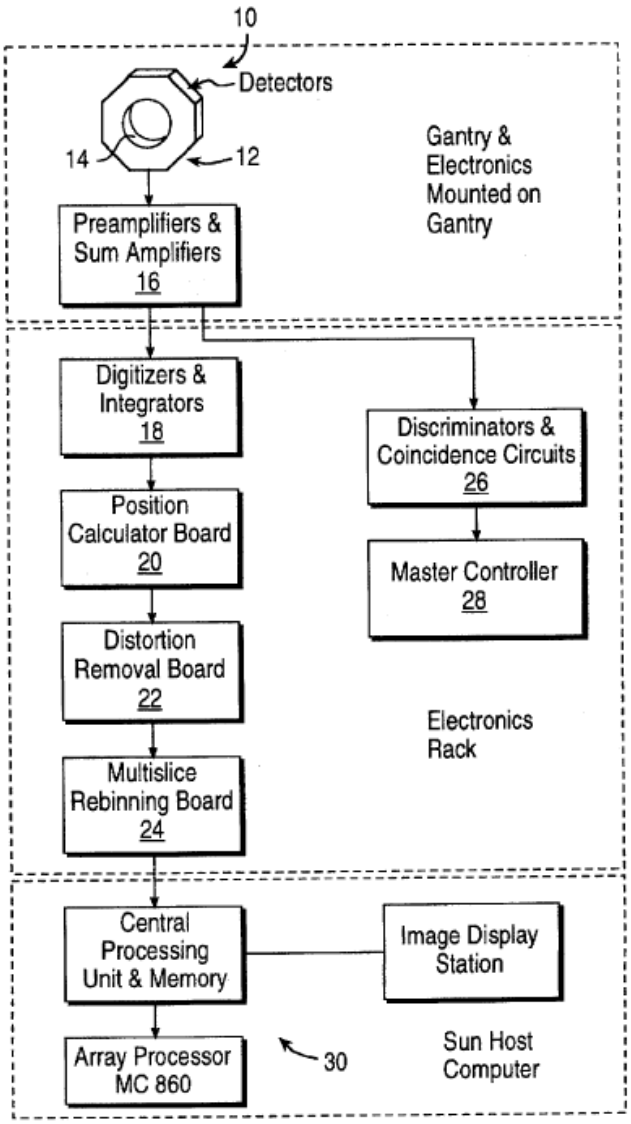
1. Muehllehner is Prior Art

[150] Muehllehner is directed to forming three-dimensional PET images from two-dimensional slices. Ex-1006 ("Muehllehner"), Abstract, 1:65-2:14, 12:48-60, 13:18-38 (claim 1), Figs. 2, 2a, 11-13. Muehllehner is a U.S. patent that issued April 28, 1998, more than five years before the asserted priority date of the '353 patent. Muehllehner, cover. I understand that Muehllehner is accordingly a prior art reference under pre-AIA 35 U.S.C. § 102(b).

2. Muehllehner Teaches Forming 3D PET Images from 2D Slices

[151] Muehllehner describes forming three-dimensional PET volume images from two dimensional slices. Muehllehner, Abstract, 1:65-2:14, 12:48-60, 13:18-38 (claim 1), Figs. 2, 2a, 11-13. Muehllehner discloses using, for example, detectors, a gantry, and a computer system to reconstruct PET images. *E.g.*, Muehllehner, 3:27-58, Fig. 1.

FIG. 1



Muehllehner, Fig. 1

[152] Muehllehner explains its methods reduce blurring in the z-direction when creating volume images. Muehllehner, Abstract, 1:13-63. Muehllehner teaches an "axial filtering" method that "eliminates unacceptable blurring in the reconstructed volume." Muehllehner, 6:49-9:3 (describing image filtering and

sinogram filtering), Fig. 2. This approach involves processing projection data (e.g., rebinning two-dimensional data and filtering. Figure 2 and 2a provide an example.

FIG. 2

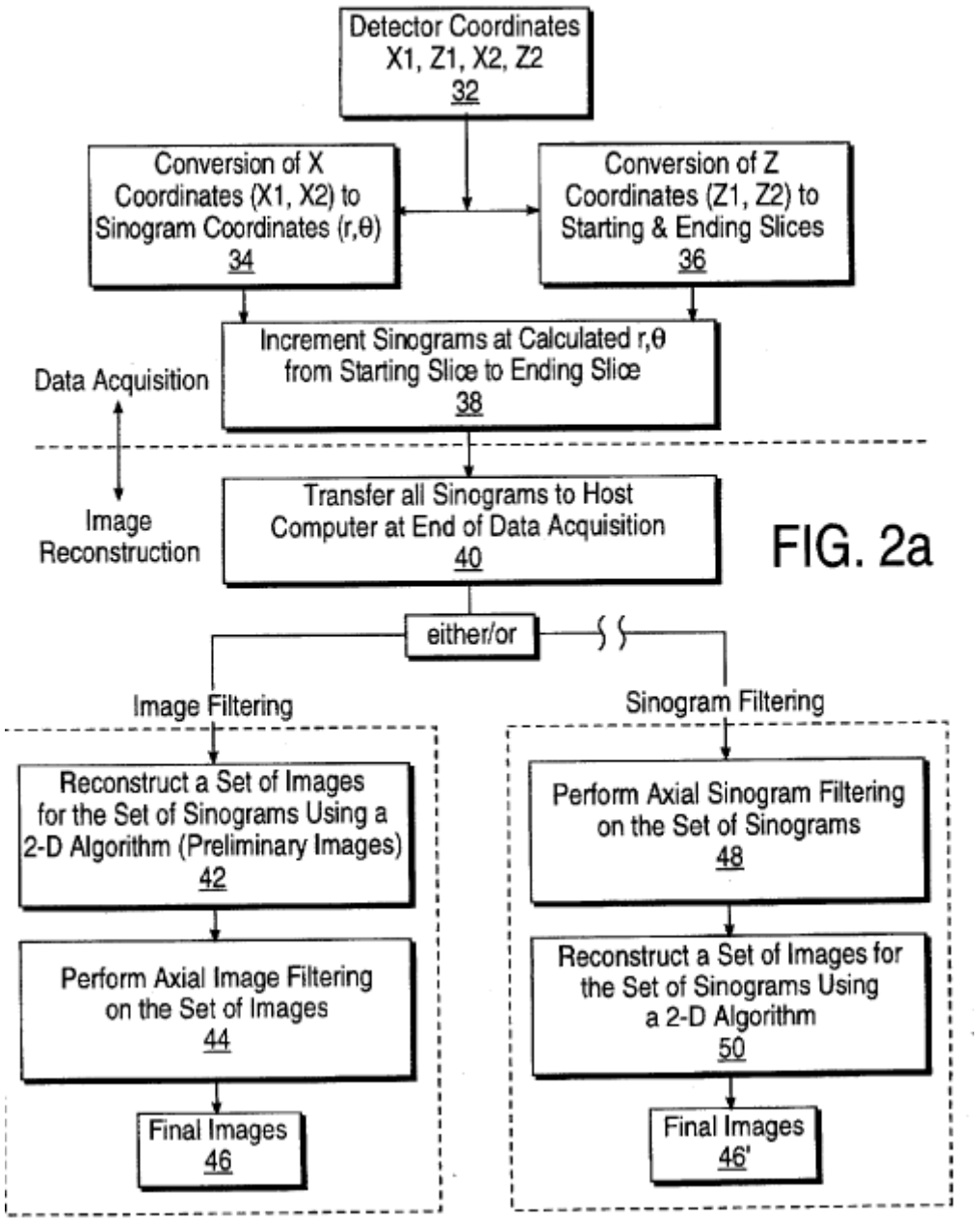


FIG. 2a

Muehllehner, Figs. 2-2a

[153] Muehllehner discloses its methods "reduce the overall time required for collecting and reconstructing data" because it employs multi-slice rebinning of projection data and axial filtering. Muehllehner, 10:60-64. Muehllehner explains this method saves time and reduces cost as compared to other known 3D reconstruction techniques at the time. Muehllehner, 2:39-63 (identifying goal to reduce time and cost of PET collection), 10:54-67, 11:24-30.

C. Overview of Wainer (Ex-1005, U.S. 5,871,013)

1. Wainer is Prior Art

[154] Wainer provides methods to register structural and functional images. Wainer, Abstract, 3:26-33. Wainer is a U.S. Patent issued February 16, 1999, more than three years before the asserted priority date of the '353 patent. Wainer, Cover. I understand that Wainer is accordingly a prior art reference under pre-AIA 35 U.S.C. § 102(b).

2. Wainer Provides Dual-Gating Methods for Structural and Functional Medical Images

[155] Wainer discloses a method of registering structural and functional images. Wainer, 3:26-33. Wainer's structural images include Single Photon Transmission Computerized Tomography (SPTCT) images and CT images. Wainer, 1:18-61, 2:24-53, 6:10-17. Its functional images include Single Photon Emission Computerized Tomography (SPECT) and a combination of SPTCT and SPECT

known as Simultaneous Transmission and Emission Tomography (STET), where the SPECT component of STET involves both emission data and generates functional images. Wainer, 1:18-61, 2:24-53, 4:23-55. Wainer explains its techniques apply to other structural and functional modalities. Wainer, 9:24-31.

[156] Wainer discloses superimposing images at different time points to track early and late radiotracer distribution. Wainer, 5:3-14 (discussing time points associated with areas 2, 2' and 6, 6'), 7:32-49, Fig. 4A-4B. For example, Figure 4A (below) shows superposition of functional images at different timepoints. Wainer, 4:8-11, 7:32-41, Fig. 4A. Figure 4B (below) shows superposition of a functional image and structural CT image at one timepoint. Wainer, 4:12-14, 7:33-41, Fig. 4B. Wainer uses the term "processing" to describe image subtraction, superposition, outlining and coloring images, and Wainer flexibly teaches "simultaneous processing and viewing of several images at once." Wainer, 7:32-49.

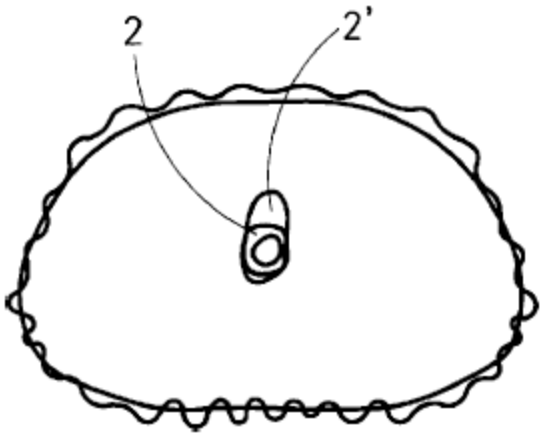


FIG.4A

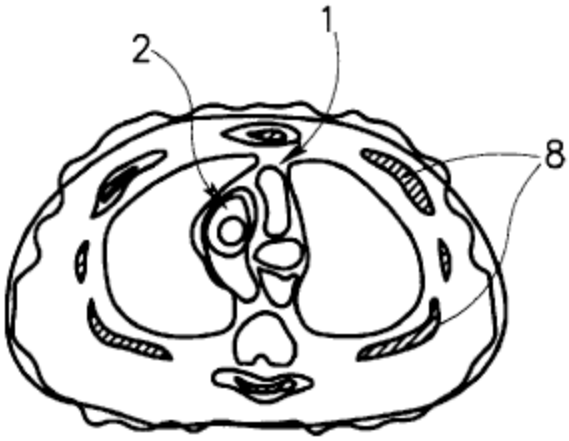


FIG.4B

Wainer, Figs. 4A-4B.

[157] In addition, Wainer teaches that structural images at different timepoints may need to be registered prior to combination owing to changes due to breathing and placement on the examination table. Wainer, 5:32-49. Wainer provides methods of registering structural images to facilitate the combination of

functional images at different times to track changes in or evolution of radiotracer distribution. Wainer, 5:50-6:9. For example, Wainer teaches to register two functional images 6 and 6' taken at different time points after registration of their corresponding functional images. Wainer, 6:5-6:9.

[158] Wainer discloses collecting gated structural and functional images, which generates a plurality of images corresponding to different phases of a gated motion. Wainer, 3:33-60 (disclosing gating methods for "body rhythms"), 4:56-61 (same), 8:38-59 (gated CT and gated STET images), 8:60-9:20 (discussing Fig. 6), Fig. 6. Wainer discloses a simple approach to gating that was entirely conventional at the time—grouping projections into time bins associated with different motion states determined from sensor data and reconstructing images for each phase of a repetitive cycle (e.g., breathing or cardiac cycle). *E.g.*, Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6. Wainer explains that gating helps reduce motion-induced "smearing" in images and it facilitates registration of images taken with different modalities. Wainer, 3:33-60, 8:38-59.

XI. OVERVIEW OF THE GROUNDS

Grounds		Challenged Claims	Basis	Prior Art
Weese Grounds	1	1-18	§103	Weese
	2	1-18	§103	Weese in view of Muehllehner
	3	1-18	§103	Weese in view of Wainer
Wainer Ground	4	1-18	§103	Wainer

XII. GROUND 1 (WEESE)

A. Ground 1 Overview: Weese

[159] In my opinion, claims 1-18 of the '353 patent are unpatentable in view of Weese.

[160] Weese discloses and renders the claims obvious in multiple ways. For example, my analysis below shows that Weese discloses and renders obvious [1d] and [1e] ***thirteen*** different ways.

1. Weese Discloses Acquiring CT and PET Images Using Separate, Independent Systems

[161] Some of my analysis applies to Weese's embodiments that combine CT and PET images collected from separate, independent CT and PET systems. *See*

Weese, ¶¶ [0037], [0072]-[0074], [0080]. Here, I provide an overview of Weese's methods for images collected with separately located CT and PET systems, not co-located systems as in the example "combination apparatus" of Weese's Figure 6. This approach was not unusual. At the time, it was common for CT and PET systems to reside in different rooms, and co-registration techniques were widely known. Ex-1008, 735 (combining PET with CT "usually requires moving the patient from the PET system to the CT or MRI system"); Ex-1009 (CT and PET registration); *see* Wainer, 2:39-53 (registering images), 4:28-30 (same), 5:28-29 (same).

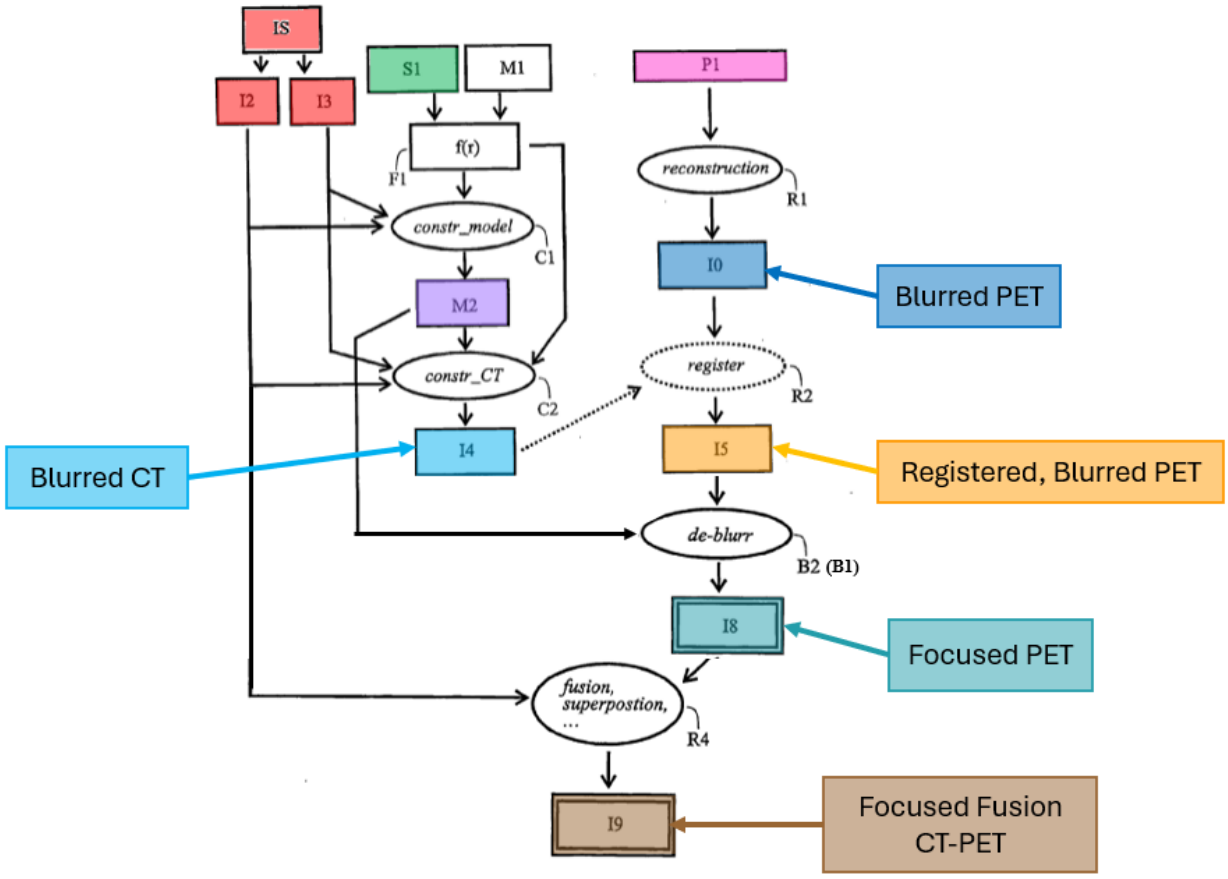
[162] Weese describes a simple registration step R2 to align coordinates between images collected on separate CT and PET systems. Weese, ¶¶ [0072]-[0074], [0080]. Weese twice acknowledges registration is "generally known" and provides one suitable example technique. Weese, ¶¶ [0073]-[0074] (citing Ex-1009). That example involves non-rigid transformations between PET and CT coordinates that accounts for translation, rotation, and deformations of objects in the image. Weese, ¶ [0073] (citing Ex-1009); Ex-1009. Figure 1 depicts the registration step as based on a blurred CT image I4 that is constructed from CT images and sensor measurement on CT and PET systems. Weese, ¶¶ [0063]-[0070], Figs. 1.

[163] Outside this registration step, Weese takes the same approach when using separate CT and PET systems as for a combination CT-PET apparatus. Weese, ¶¶ [0047]-[0080], Figs. 1-2. Weese teaches the same motion correction and image

fusion techniques irrespective of whether data were collected on combined or separate PET and CT systems when using the methods of Figures 1 and 2. *Id.*; *see* § X.A (Overview of Weese (U.S. 2005/0226527)).

2. Weese's Flexible Approach to Correcting Motion Artifacts When Combining CT and PET Includes Modifying Figure 1 Using the "Focusing" Approach of Figure 2

[164] Weese expressly teaches an "alternative for the method of Figure 2 (not shown)" when "coordinate systems of the image I0 and the images I2 and I3 are different," i.e. for separate, independent CT and PET systems that are not co-located. Weese, ¶ [0080]. *See* § X.A (Overview of Weese (U.S. 2005/0226527)). This variation incorporates Figure 1's registration to align PET images with CT coordinates, then it employs Figure 2's "focusing" approach to generate a **focused PET image** representing just one "state of motion" with "practically no motion artifacts." *See* § X.A (Overview of Weese (U.S. 2005/0226527)); Weese, ¶ [0080]. Weese then combines the **focused PET image** with an **already-focused CT image** to generate a **fused, combined CT-PET image**. *See* § X.A (Overview of Weese (U.S. 2005/0226527)); Weese, ¶¶ [0078]-[0080]. The focused PET and CT images may be at ***any*** motion state, including but not limited to full inhale or full exhale. Weese, ¶¶ [0078]-[0080]. Weese describes this modification, but its figures do not depict this embodiment, so I show it here:



Weese, modified Figs. 1-2 (annotated) (*see* § X.A)

[165] It is my opinion that Weese's discussion of Figures 1 and 2 expressly discloses the embodiment I depict above. Weese, ¶¶ [0047]-[0052], [0062]-[0080]; *See* § X.A (Overview of Weese (U.S. 2005/0226527)). While the modified figure depicts combining PET and CT to form I9 at motion states corresponding to I2, Weese discloses combining at any motion state captured by the motion model. Weese, ¶¶ [0078]-[0080]. And Weese explains that it includes embodiments outside those specifically represented in figures. *E.g.*, Weese, ¶¶ [0074] (registration "method is not shown in FIG. 1, but can nevertheless be used herein."), [0080]

("alternative" to Fig. 2 is disclosed but "not shown."). Here, I have simply represented in a schematic what Weese describes in words. But to the extent Patent Owner disputes whether Weese discloses the above method because it does not include the modified figure I show above, it is my opinion that a person of ordinary skill would have found the above method obvious over Weese and would have had a reasonable expectation of success because Weese teaches this embodiment.

[166] As a starting point, Weese generally teaches a flexible approach to correcting motion artifacts and combining CT and PET images. *E.g.*, Weese, Abstract, ¶¶ [0013] (generally teaching to use motion data "in various ways in supplementary image processing or image forming steps, resulting in a higher quality of the resultant images."), [0018]-[0019] (interchanging approaches), [0029] (combining claims 1 and 3 or claims 2 and 3), [0080] (combining aspects of Figs. 1-2), [0084] (combining aspects of Figs. 1-3), Figs. 1-3 (containing features common to all three figures); *see* § X.A (Overview of Weese (U.S. 2005/0226527)). Weese's flexibility provides advantages. Weese extols the value of employing more than one method of image correction and fusion. Physicians would have "desire[d]" various views of combination images "to enable comparison or a combination of information [in an unaltered image] with information from other [motion corrected] images." Weese, ¶ [0075]. And Weese states generally that "[i]t is an object of the invention

to increase the information content of images containing motion artifacts," which motivates its flexible approach. Weese, ¶ [0004].

[167] And, as I just discussed, Weese expressly discloses combining aspects of the motion correction and fusion methods of Figures 1 and 2 by implementing Figure 1's registration in Figure 2's process. Weese, ¶ [0080]; *see* § X.A (Overview of Weese (U.S. 2005/0226527)). Weese specifically discloses "apply[ing] the focusing B1 to the image **I5** instead of to the combination image **I6** in Fig. 1." Weese, ¶ [0080]. Image **I5** is a reconstructed and registered blurred PET image. Weese, ¶ [0072]. Paragraph [0080] describes focusing this blurred PET image to generate the focused PET image shown as **I8**, above, prior to combination with a CT image.

[168] In Weese, "focusing" sharpens an image that contains artifacts from multiple states of motion, resulting in an image with "only one state of motion." Weese, ¶¶ [0033] (focusing algorithm to resolve "any state of motion"), [0077]-[0080]. Weese gives a suitable example "focusing" algorithm from a 1989 article, which long predates the 2003 priority date of the '353 patent. *Id.* (citing Ex-1010). Such "focusing" would have been used to produce a view of the chest at maximum inhalation (or any other respiration stage) from a PET image that contains information collected over many breathing cycles over 30-minutes, for example . Weese, ¶¶ [0033] (focusing on any state), [0049]-[0051] ("acquisition of the

projections P1, [] may last from a few minutes to one hour," causing respiration artifacts in PET images), [0062] (discussing full inhalation), [0077]-[0080] (focusing on any state), Fig. 4 (breathing cycle).

[169] Over Weese's teachings to flexibly combine its methods, a POSITA would have found it obvious to use the registration method of Figure 1, including creating **blurred CT image I4** to generate a **registered, blurred PET image I5**, and applying a focusing technique to generate a **registered, focused PET image I8**, as I show in the above modified schematic. Weese describes the focusing steps B1 of Figure 1 and B2 of Figure 2 as "analogous" and teaches they can be used interchangeably. Weese, ¶ [0079]. Indeed, Weese at paragraph [0080] explicitly teaches this exact approach.

[170] Then, because Weese presents this approach as an "alternative" to Figure 2, Weese teaches generating a **focused PET-CT image** by combining the **registered, focused PET image** with the corresponding the CT image **I2** (or **I3** or any other CT image at any motion state created using **M2**), as I show in the above schematic. Weese, ¶¶ [0078]-[0080]. Not only does Weese directly teach this approach, but a POSITA would have been motivated to implement this process as a suitable way to achieve a focused fusion PET-CT image. Doing so would have "increase[d] the content of images containing motion artifacts," a key goal of Weese. Weese, ¶ [0005]. A POSITA would have made a **focused PET-CT image** using

this approach in view of Weese's teaching that superimposed focused images advantageously present of multiple types of accurate information to a viewer for comparison. Weese, ¶¶ [0018], [0022], [0034]-[0035, [0085], Figs. 1-2, claim 8.

[171] The resulting **focused PET-CT image** would have been predictable. Figure 2 and the modified figure I present above use the same approach—they combine a focused PET and focused CT image to generate a focused PET-CT image. Weese, ¶¶ [0078]-[0079]. Using the approach of Figure 2 when incorporating a registration step merely calls for employing Weese's disclosed methods of combining a "sharper PET image" that "represents the same state of motion as an acquired CT image" (the **registered, focused PET image**) with the corresponding CT image. Weese, ¶¶ [0079]-[0080]. Indeed, the "comparison step[s]" used to combine CT and PET images are "the same methods" in both figures. Weese, ¶ [0079].

[172] Thus, the only difference between this variation and Figure 2 is to include steps to register the PET image to CT coordinates prior to combining the images. *See* § X.A (Overview of Weese (U.S. 2005/0226527)). I have shown and described nothing more than the simple substitution that Weese expressly discloses in text, which would have achieved predictable results. A POSITA would accordingly have found it obvious to implement the variation as I have drawn it.

B. Claim 1

[173] In my opinion, claim 1 is obvious over Weese.

1. [1p] A method of forming an image of a mobile object, comprising:

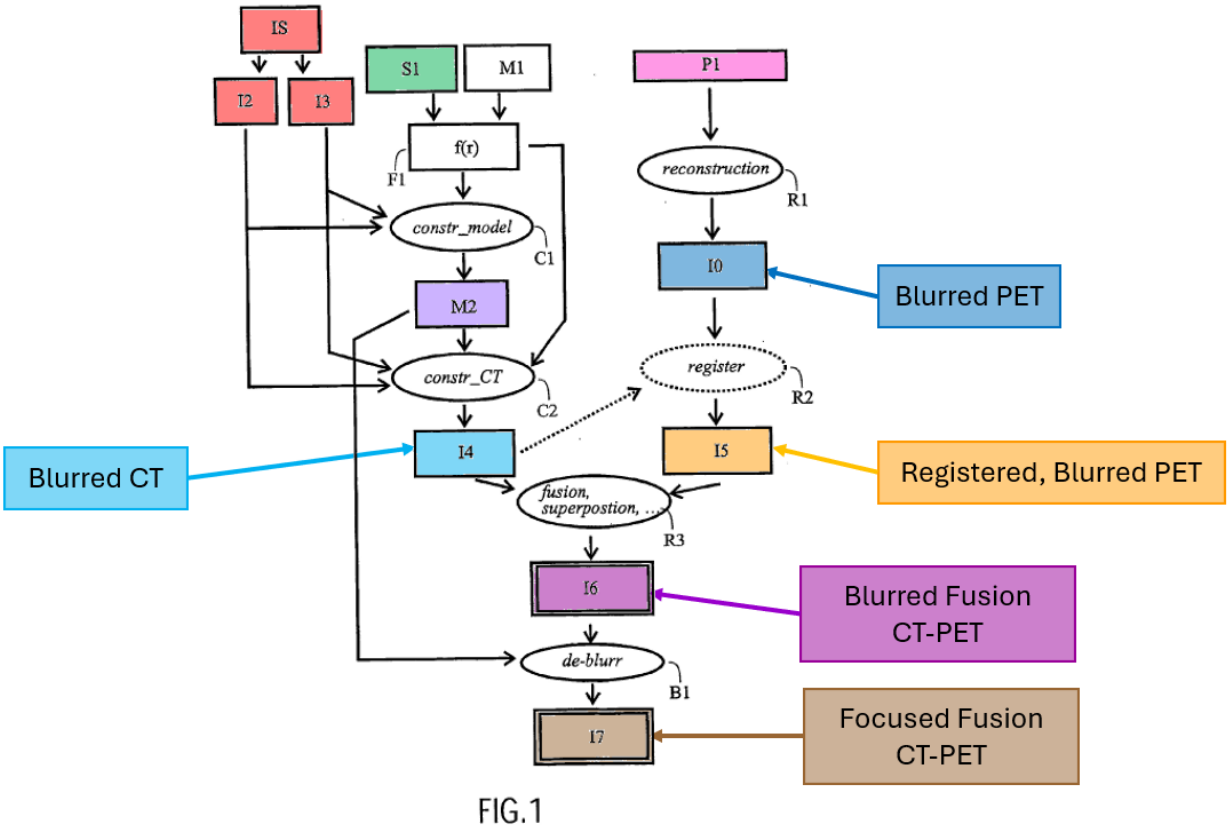
[174] Weese discloses "a method of forming an image of a mobile object," as recited in [1p].

[175] Weese addresses the problem of motion artifacts when combining CT and PET technology. *See* § X.A (Overview of Weese (U.S. 2005/0226527)). For example, Weese discloses imaging a patient and their organs (i.e., objects) as they move (e.g., due to respiration). *E.g.*, Weese, Abstract (stating, for example, "[t]he invention relates to a method in which the information contents of an **image of a moving object** is enhanced," (emphasis added)), ¶¶ [0001]-[0018], Figs. 1-3, 6. Weese interprets the meaning of motion "in a very broad sense" that encompasses "very complex natural motion (human heart) or merely a linear, uniform motion (a sphere rolling at a constant speed)." Weese, ¶ [0009]. Weese's techniques address motion that occurs during CT and PET acquisition, including due to heartbeats and/or breathing. *E.g.*, Weese, ¶¶ [0009], [0049], [0062], Figs. 4-5. Such motion creates false distortions (artifacts) in images. Weese, ¶¶ [0004]-[0005]; § VII (TECHNOLOGICAL BACKGROUND). Motion in CT and PET images was "unavoidable." Weese, ¶¶ [0002]-[0003].

[176] To achieve this goal, Weese discloses using sensors to collect a "motion signal" (i.e., motion data) and combining first and second images based on the motion signal. Weese, ¶¶ [0057], [0060]. Weese teaches acquiring "a first image of a moving object" which "contain[] artifacts which are caused by the object motion." Weese, Abstract, ¶ [0002]. **PET image I0** is an example image with motion artifacts, and it is an "image of a moving object," as claimed in [1p]. Weese, ¶¶ [0003]-[0011], [0047]-[0051], Figs. 1-2. So is PET image **I10**. Weese, ¶¶ [0081]-[0084], Fig. 3. Using the motion model, Weese describes registering **I0** to form a **blurred, registered PET image I5**, forming a **focused PET image**, and forming a focused combination **CT/PET image**. Weese, ¶¶ [0078]-[0080]; § XII.A (Ground 1 Overview: Weese). This same method would have been used to register PET image **I10** of Figure 3 as well. Weese, ¶ [0084] (Fig. 3's method "can be combined at will" with method of Figs. 1-2).

[177] Weese also discloses acquiring "further images" of the moving object using a "second imaging method" and combining the first images and further images with a "motion model." Weese, Abstract, ¶¶ [0003], [0006]-[0007], [0010]-[0011], [0015]-[0018], [0023]-[0025], [0033]-[0035]. **CT images I2** and **I3** are examples of Weese's "further images," and they are also each "an image of a moving object," as claimed in [1p]. Weese, ¶¶ [0003], [0052], [0062].

[178] Figure 1, Figure 2, the variation of Figure 2 that I show and discuss above, and Figure 3 all implement the foregoing methods to form an image of a moving object. Weese, ¶¶ [0046]-[0084]. Figs. 1-3. That is, Weese discloses forming images **I0**, **IS**, **I2**, **I3**, **I4**, **I5**, **I6**, **I7**, **I8**, **I9**, and **I10**, as shown in the figures below. §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). Each of these images are an "image of a moving object" (e.g., an image of a patient, patient organ, tumor, etc.), as recited in [1p].



Weese, Fig. 1 (annotated)

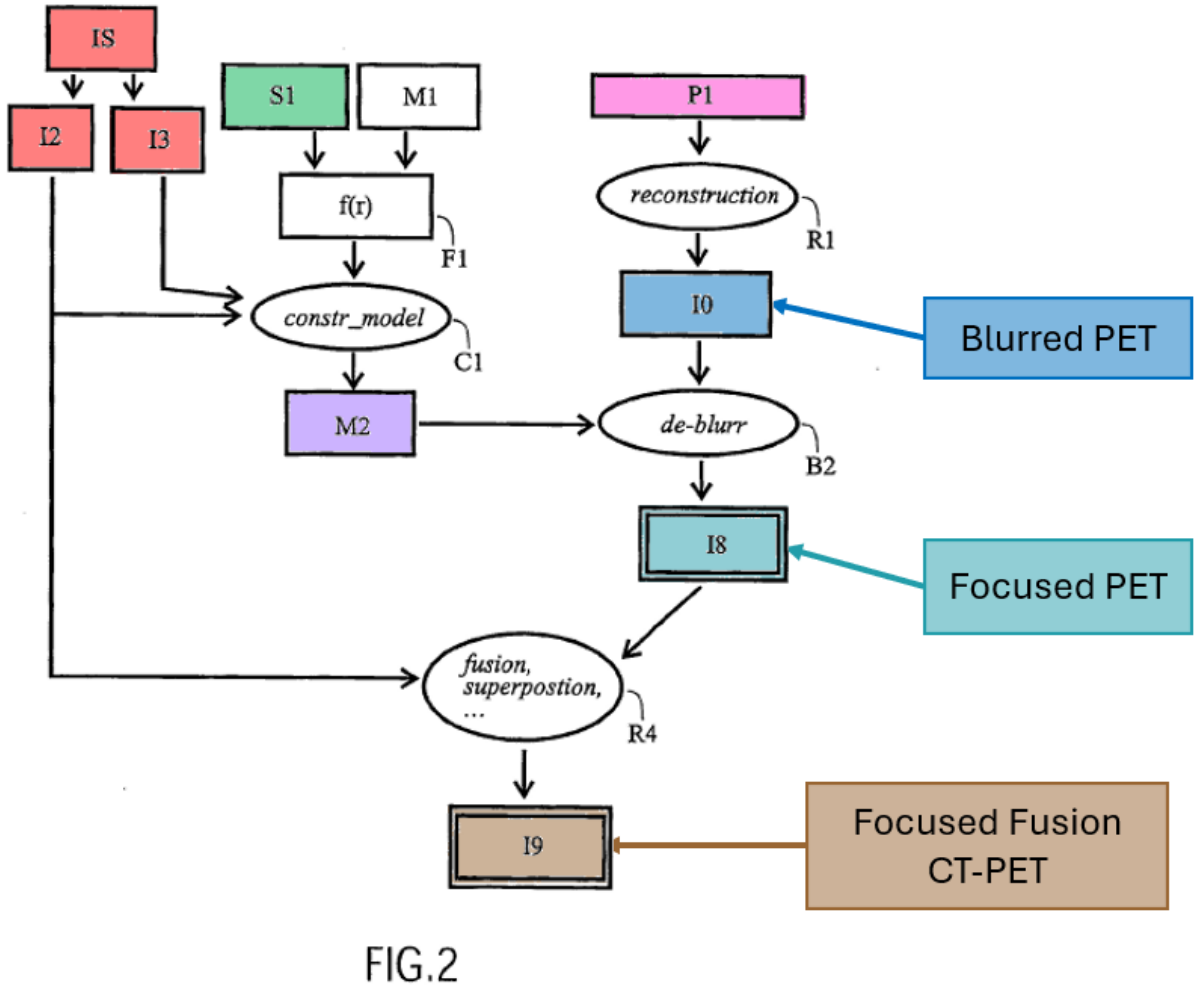
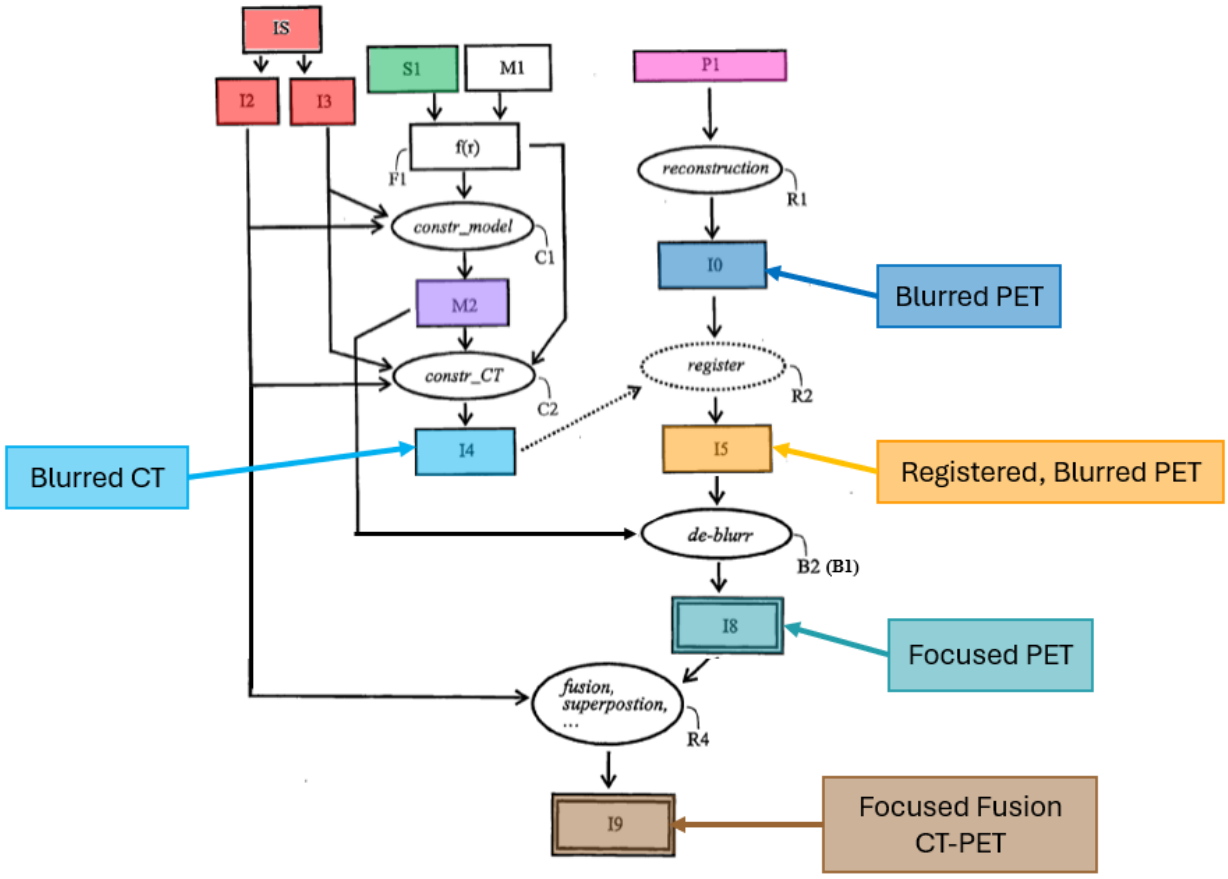


FIG.2

Weese, Fig. 2 (annotated)



Weese, modified Figs. 1-2 (annotated)

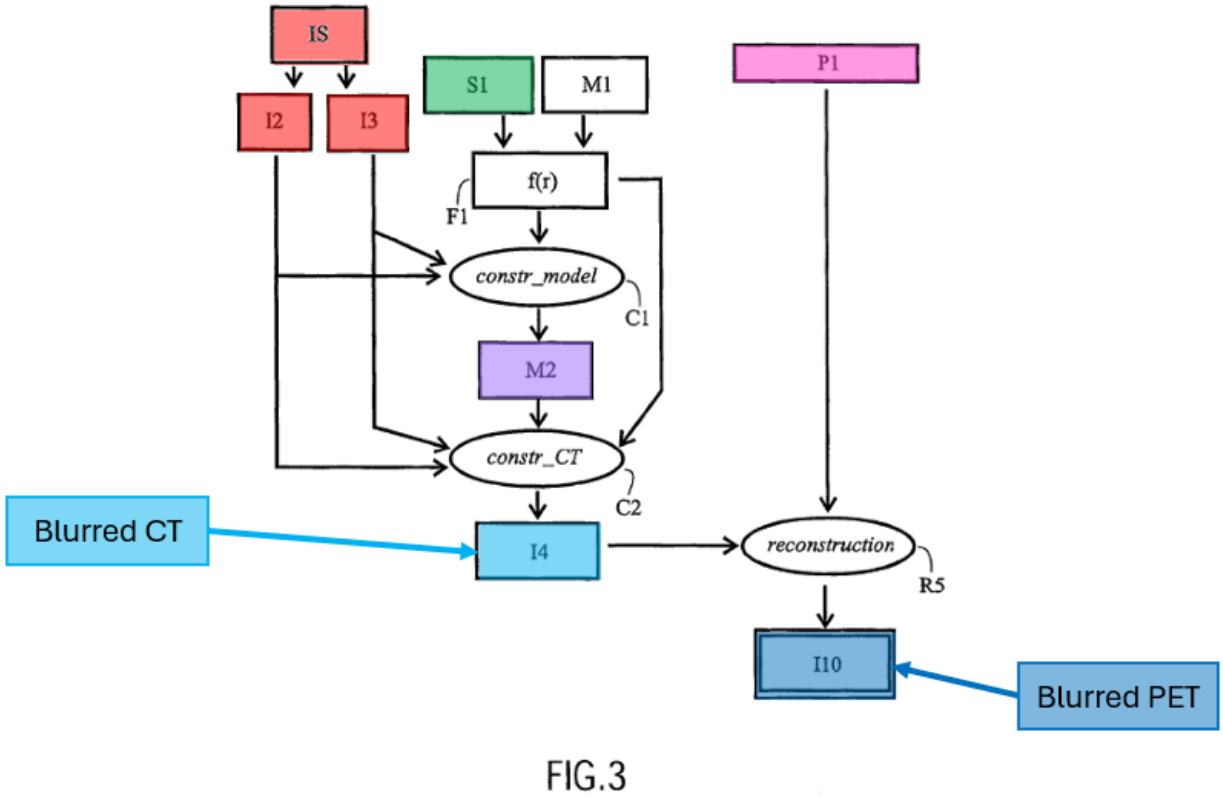


FIG.3

Weese, Fig. 3 (annotated)

2. [1a-i] obtaining a plurality of first images of the mobile object using a first imaging technique;

[179] In my opinion, Weese discloses "obtaining a plurality of first images of the mobile object using a first imaging technique," as recited in [1a-i].

[180] The '353 patent certainly did not invent obtaining a plurality of images of a mobile object. This was routine at time. *E.g.*, Ex-1008, 371 (Bushberg textbook, addressing motion artifacts during CT image acquisition); Weese, ¶¶ [0001]-[0003] (describing CT as a "further image of a moving [a] moving object"); Ex-1015 (effects of "tidal" breathing on CT and PET); Ex-1016 (showing

need for breathing protocols to reduce artifacts when merging PET and CT images); Ex-1017 (1994 paper on gating CT data to account for motion); *see* § VII (TECHNOLOGICAL BACKGROUND). Weese describes motion in CT and PET images as "unavoidable." Weese, ¶¶ [0002]-[0003].

[181] Weese discloses [1a-i]. Weese teaches using CT techniques (a "first imaging technique" of [1a-i]) to acquire CT image sequence **IS** and CT images **I2** and **I3**, which are a "plurality of first images of the mobile object," as recited in [1a-i]. Weese, ¶¶ [0003], [0052], [0062], [0078]-[0080], [0083], Figs. 1-3. Images **I2** and **I3** represent "two different states of motion," such as full inhale and full exhale. Weese, ¶ [0062]. Weese's method may capture **I2** and **I3** as "instantaneous images" or "extract[]" **I2** and **I3** "from [a] sequence [of CT images] **IS**." Weese, ¶ [0062]. Together, **I2** and **I3** constitute a "plurality of first images," as recited in [1a-i], and the CT sequence **IS** also constitutes a "plurality of first images."

[182] I show **I2**, **I3**, and **IS** below in the context of Figures 1, 2, the modified figure I provided above, and Figure 3. §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). In the figures below, I added the label "**[1a-i]**" to illustrate figure elements that relate to this limitation (**I2**, **I3**, **IS**).

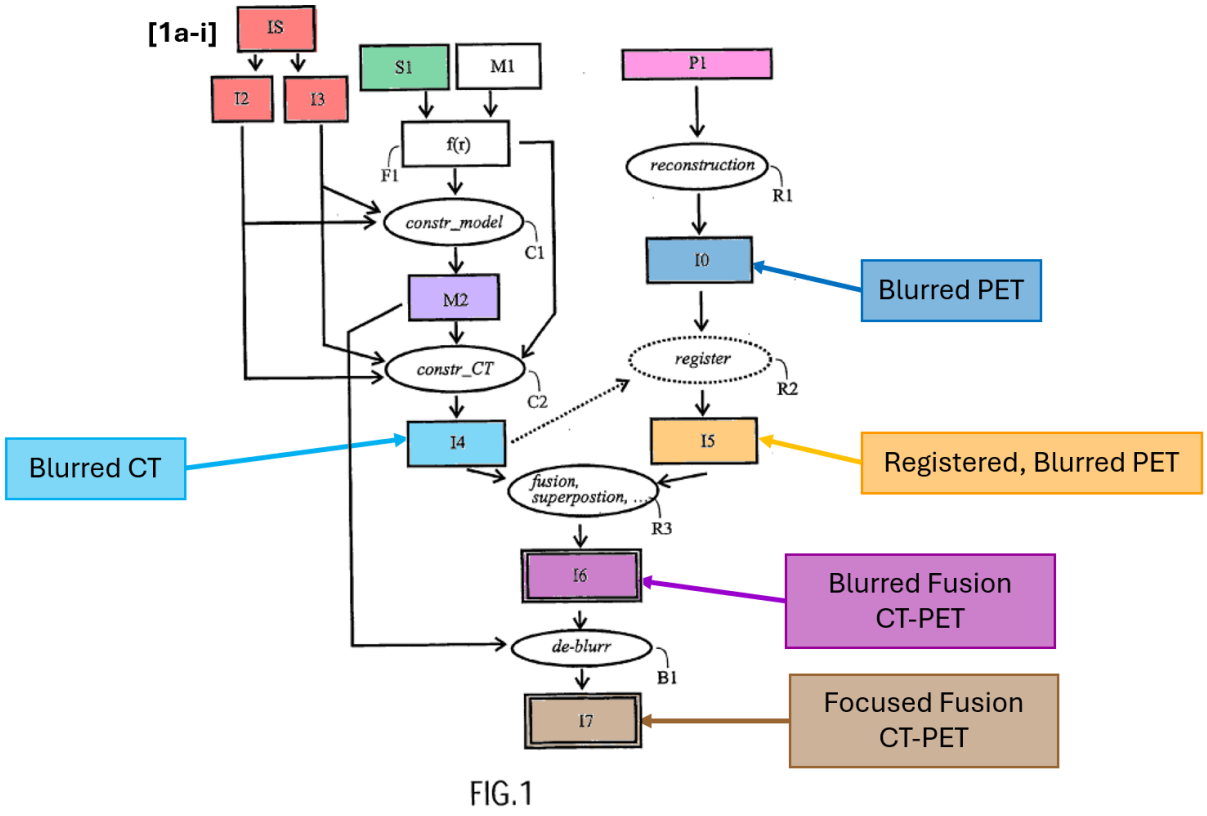


FIG.1

Weese, Fig. 1 (annotated)

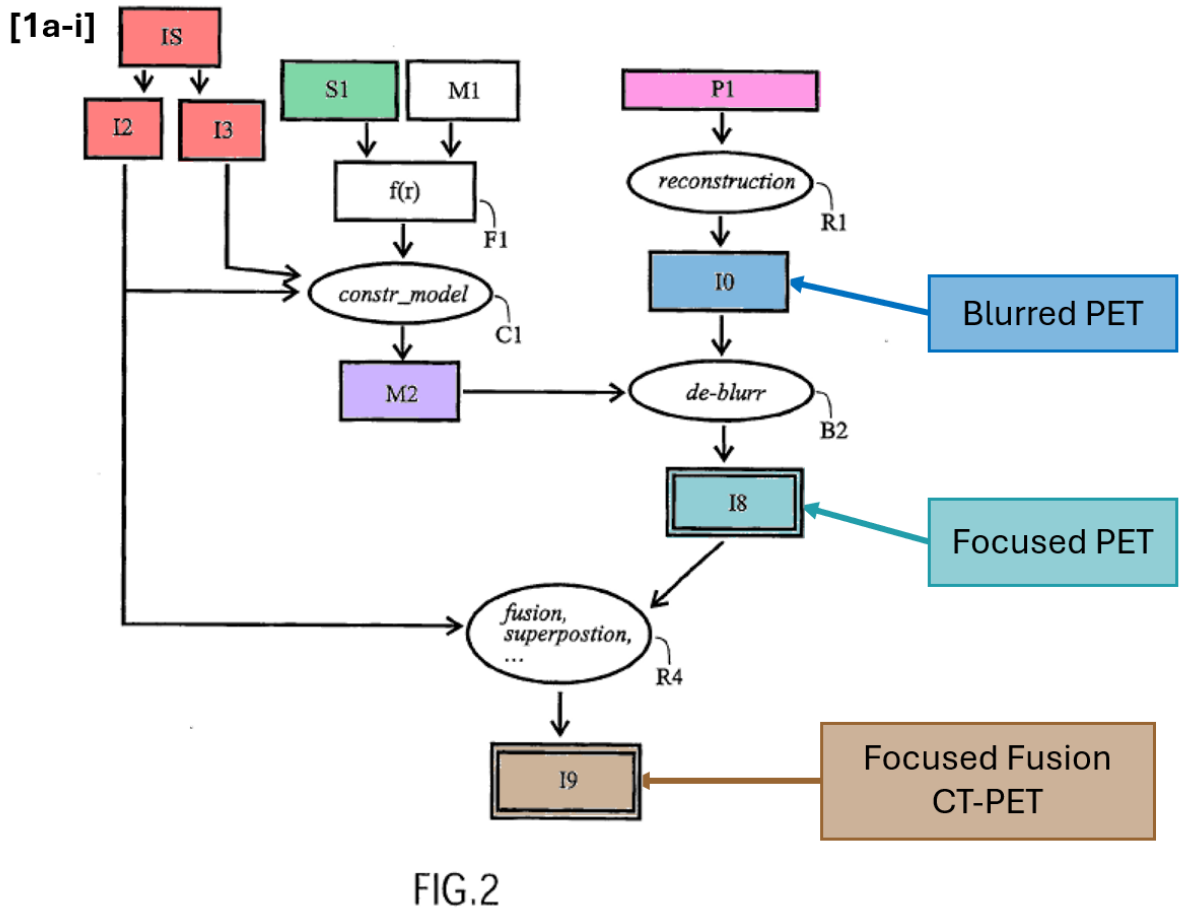
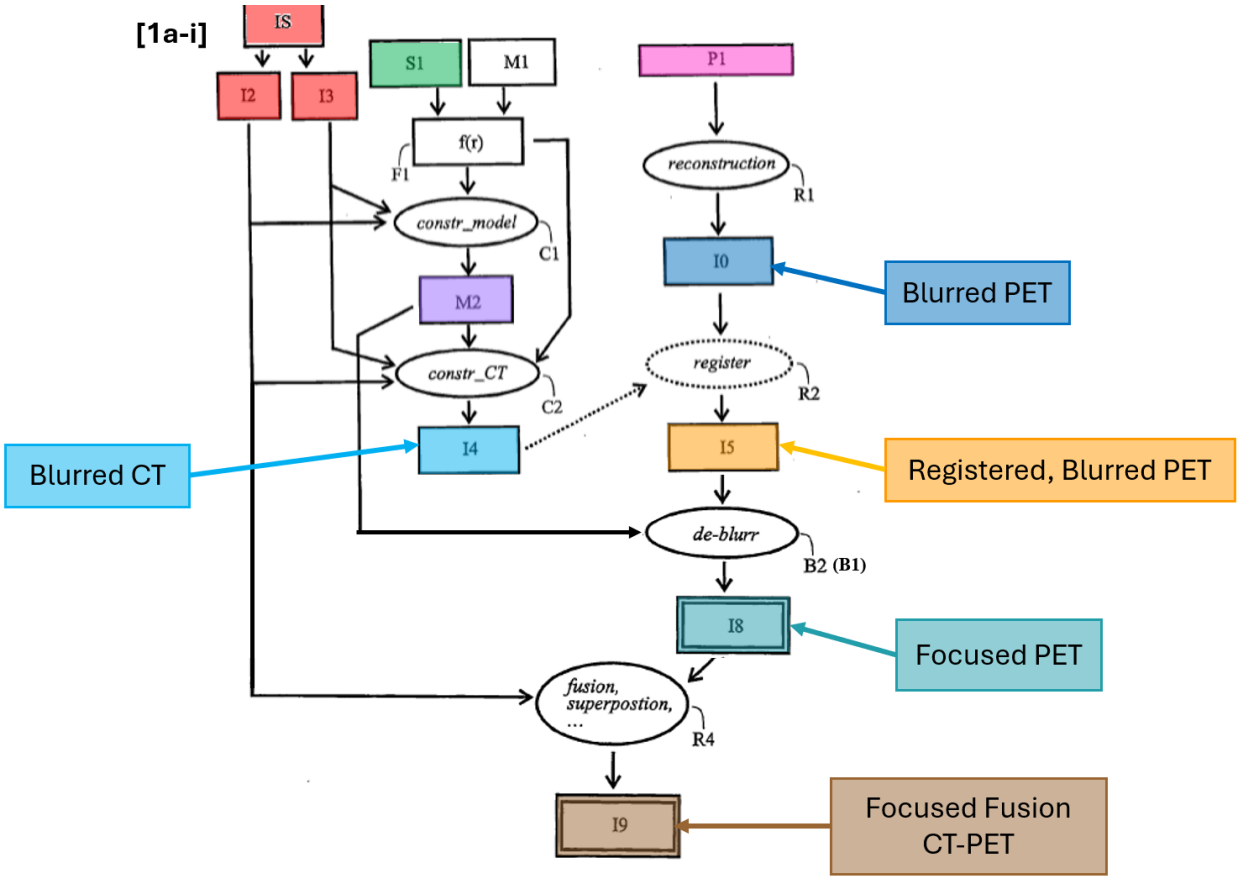


FIG.2

Weese, Fig. 2 (annotated)



Weese, modified Figs. 1-2 (annotated)

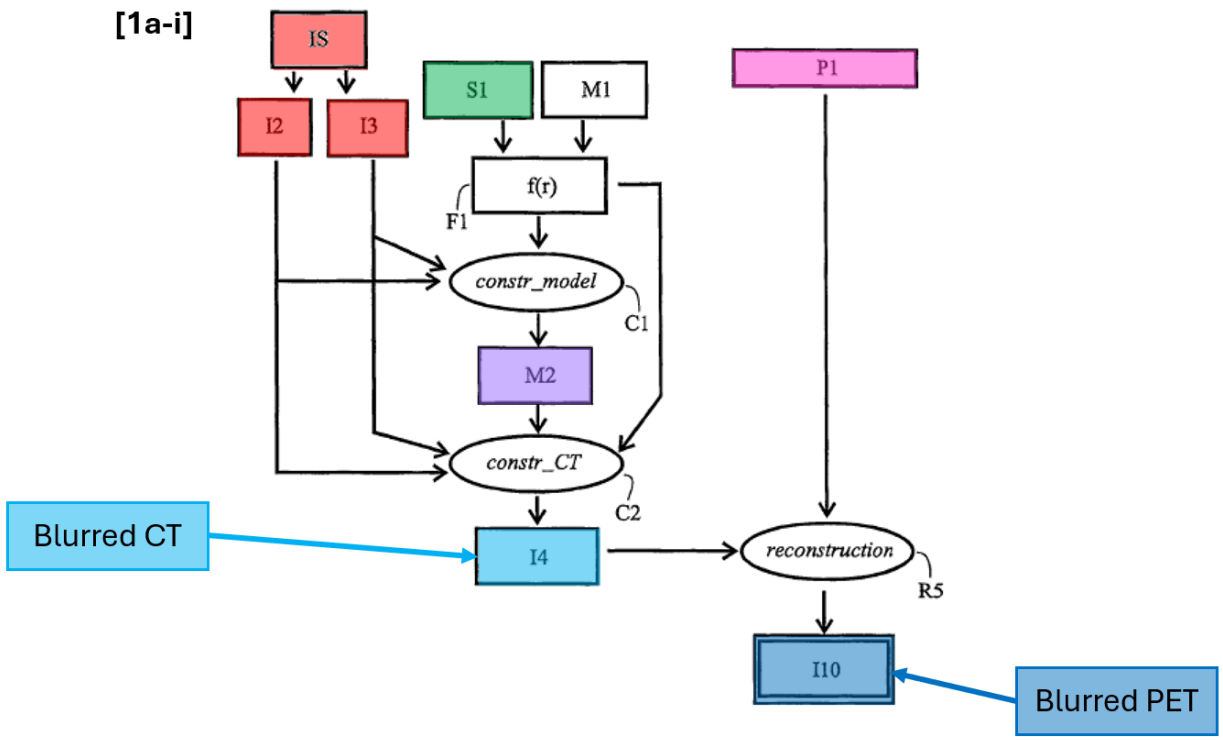


FIG.3

Weese, Fig. 3 (annotated)

3. [1a-ii] while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system;

[183] In my opinion, Weese discloses and renders obvious "obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system," as recited in [1a-ii], while "obtaining a plurality of first images of the mobile object using a first imaging technique" as recited in [1a-i].

[184] It was known at the time of the '353 patent to use independent sensor systems to monitor motion during CT and PET data collection, as I explained above.

See § VII (TECHNOLOGICAL BACKGROUND). The '353 patent did not invent that approach.

[185] For example, describing the combination apparatus of Figure 6, Weese discloses using **motion sensor 15** to obtain a plurality of measurements corresponding to patient organ movements while obtaining sequence **IS** and images **I2** and **I3** using a **CT apparatus** (including radiation source S, collimator arrangement 3, detector unit 16, and reconstruction unit 10). Weese, ¶¶ [0053]-[0057]. Weese passes data from **motion sensor 15** to **acquisition unit 12** to derive a "motion signal." Weese, ¶ [0057]. Weese teaches the motion signal derived from **motion sensor 15** "can be applied . . . to the reconstruction unit 10" in order to facilitate the selection of the measuring data that is suitable for the reconstruction" of CT images, which holds irrespective of any PET data. Weese, ¶ [0057]. Weese's "measuring data" refers to X-ray detector data used to reconstruct CT images. Weese, ¶ [0055]. Thus, Weese discloses and renders obvious using **motion sensor 15** to extract images **I2** and **I3** from sequence **IS**. Weese, ¶¶ [0031], [0057], [0065], [0072]-[0074], [0078]-[0080]; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). Weese's **motion sensor 15** (alone and in conjunction with **acquisition unit 12**) is a "**first sensor system**" that "obtain[s] a plurality of first measurements corresponding to movements of the mobile object," as recited in [1a-ii].

[186] In some embodiments when the CT and PET apparatus are combined, **motion sensor 15** may be (but need not be) sensor **S1** of Figures 1 and 2. Weese, ¶¶[0031], [0062], [0065], [0072]-[0074], [0080], [0083]-[0084], Figs. 1-3; §§ X.A (Ground 1 Overview: Weese), XII.A (Ground 1 Overview: Weese).

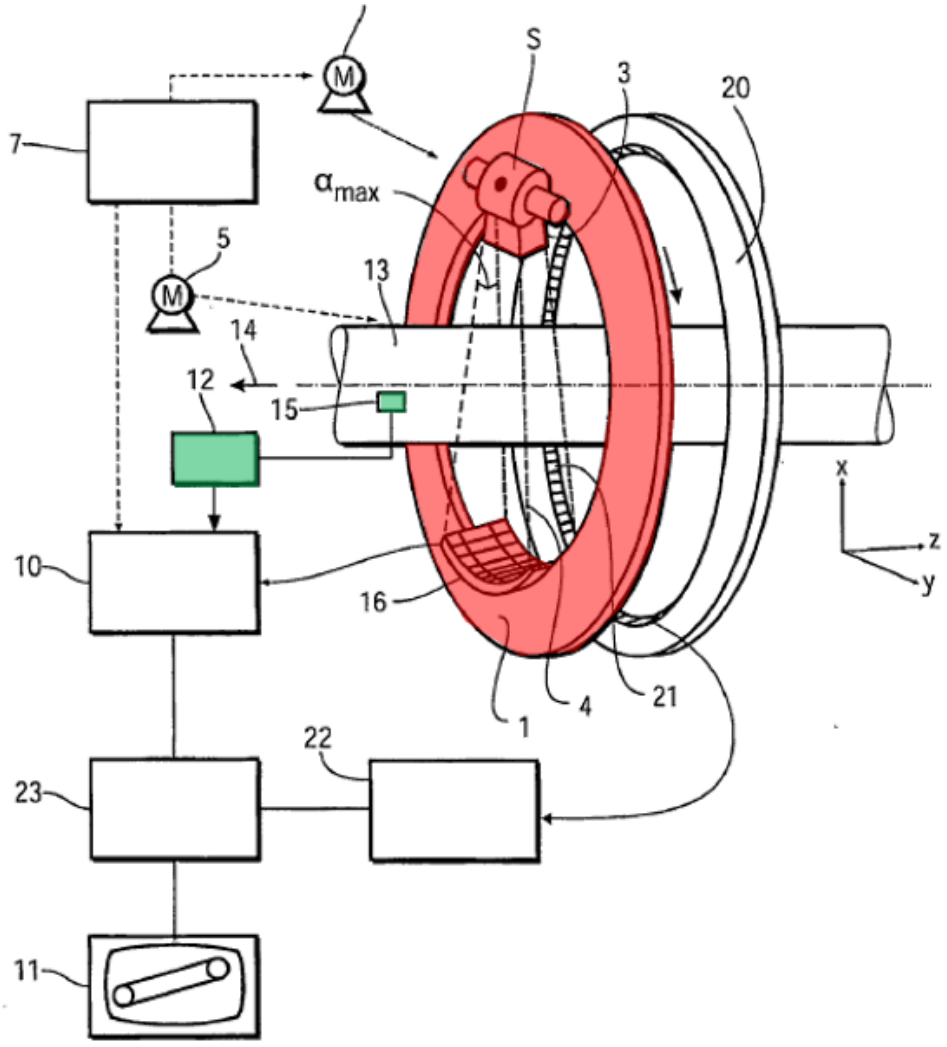


FIG.6

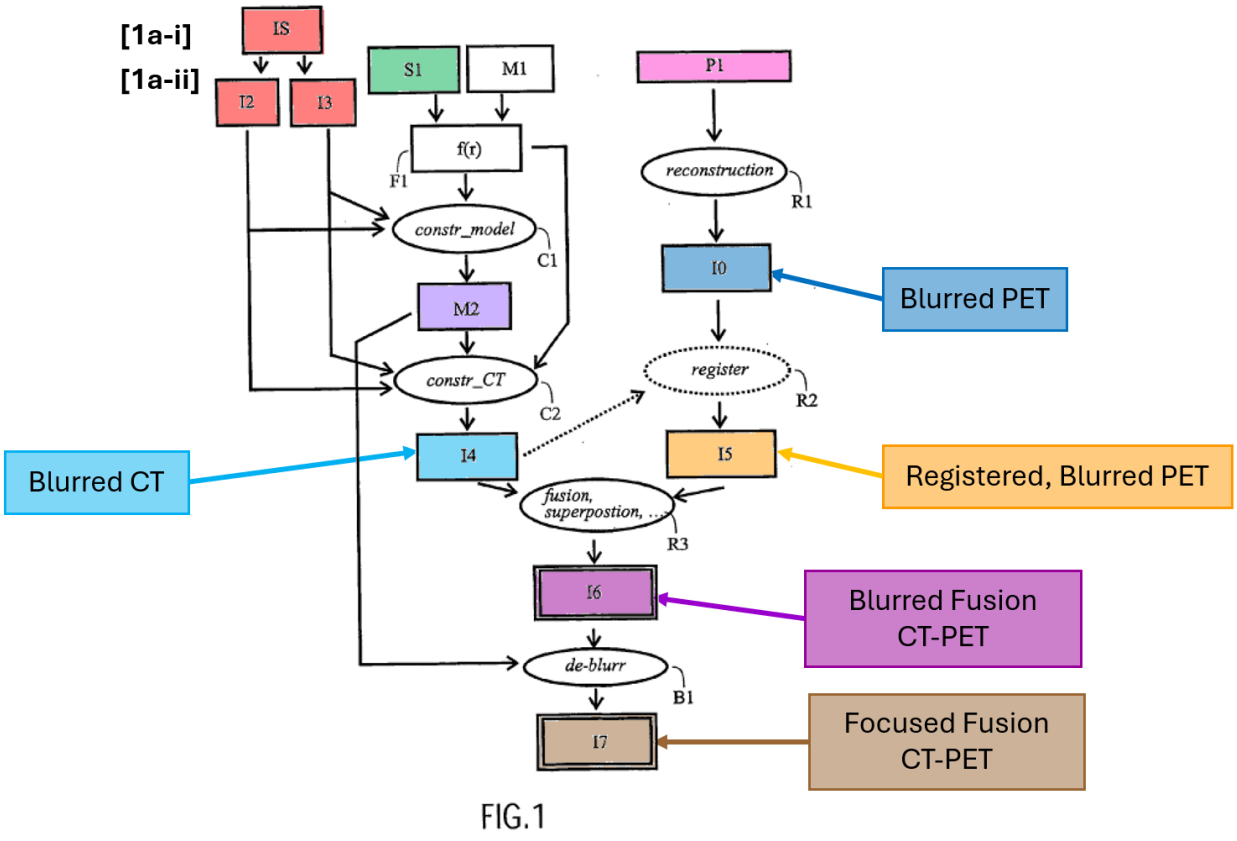
Weese, Fig. 6 (annotated)

[187] In embodiments with separate and independent CT and PET systems, the **motion sensor 15** and sensor **S1** would be separate systems because the instruments are not co-located. Weese, ¶¶ [0031], [0065], [0072]-[0074], [0080]; §§ X.A (Ground 1 Overview: Weese), XII.A (Ground 1 Overview: Weese), XII.B.3 ([1a-ii]). There, a POSITA would have understood the motion signal from **motion sensor 15** would have been used to extract images **I2** and **I3** from sequence **IS** in a CT system that was separate and independent from the PET system. Weese, ¶¶ [0031], [0057], [0065], [0072]-[0074], [0078]-[0080]; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). Weese emphasizes the need for sensors to better align CT and PET images by matching corresponding motion states in combined CT-PET systems. *See* Weese, ¶¶ [0031], [0057], [0062], [0065], [0072]-[0074], [0080]. A POSITA would have understood that the need to match motion states is even ***greater*** in separated CT and PET systems than combined systems because moving from one instrument to the other introduces potential for misalignment. Weese, ¶¶ [0072]-[0073] (difficulty of superimposing motiving use of registration techniques for separated CT and PET systems); Ex-1008, 735 (discussing problems merging images from different instruments in different rooms); Ex-1009, 1609-1610 (problem of "wildly different" conditions for CT and PET images taken separately); Ex-1010 (motion artifacts in CT images).

[188] Accordingly, a POSITA would have used the motion signal from **motion sensor 15** to extract images **I2** and **I3** from sequence **IS** in an independent CT system to improve accuracy. With this method, a patient would have experienced "natural respiratory motion" that more "accurately corresponds to the motion performed by the object during the acquisition of the **projections P1**" than when acquiring **I2** and **I3** directly (i.e., as isolated snapshots full inhale and full exhale where the patient typically holds their breath). Weese, ¶ [0062]. Weese urges use of a sensor to detect "actual motion" rather than assumed motion and generate a motion model for comparing PET and CT images. Weese, ¶¶ [0031], [0057], [0065], [0072]-[0074], [0078]-[0080]; §§ X.A (Overview of Weese (U.S. 2005/0226527)). Weese emphasizes CT-PET comparison improves when "both images exhibit substantially the same motion artifacts." Weese, ¶ [0075] (comparing I4 and I5); *see* § X.A (Overview of Weese (U.S. 2005/0226527)).

[189] For these reasons, Weese discloses and renders obvious "obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system," as recited in [1a-ii], while "obtaining a plurality of first images of the mobile object using a first imaging technique" as recited in [1a-i], by using **motion sensor 15** extract images **I2** and **I3** from sequence **IS** in embodiments with either combination or with separated CT and PET systems, which facilitates CT-PET comparisons. Figures 1, 2, the modified embodiment I previously

described, and Figure 3 all show one way to extract images using **motion sensor 15** to extract **I2** and **I3** from sequence **IS**. Weese, ¶¶ [0031], [0062], [0065], [0072]-[0073], [0075], [0078]-[0084], Figs. 1-3; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). In the below figures, I placed the label "**[1a-ii]**" near CT sequence **IS** and images **I2** and **I3** to represent that **motion sensor 15** sensor is used to extract **I2** and **I3** from **IS**, whether in an embodiment where the PET-CT system is combined and corresponds to **S1** or in an embodiment with a separated CT and PET systems.



Weese, Fig. 1 (annotated)

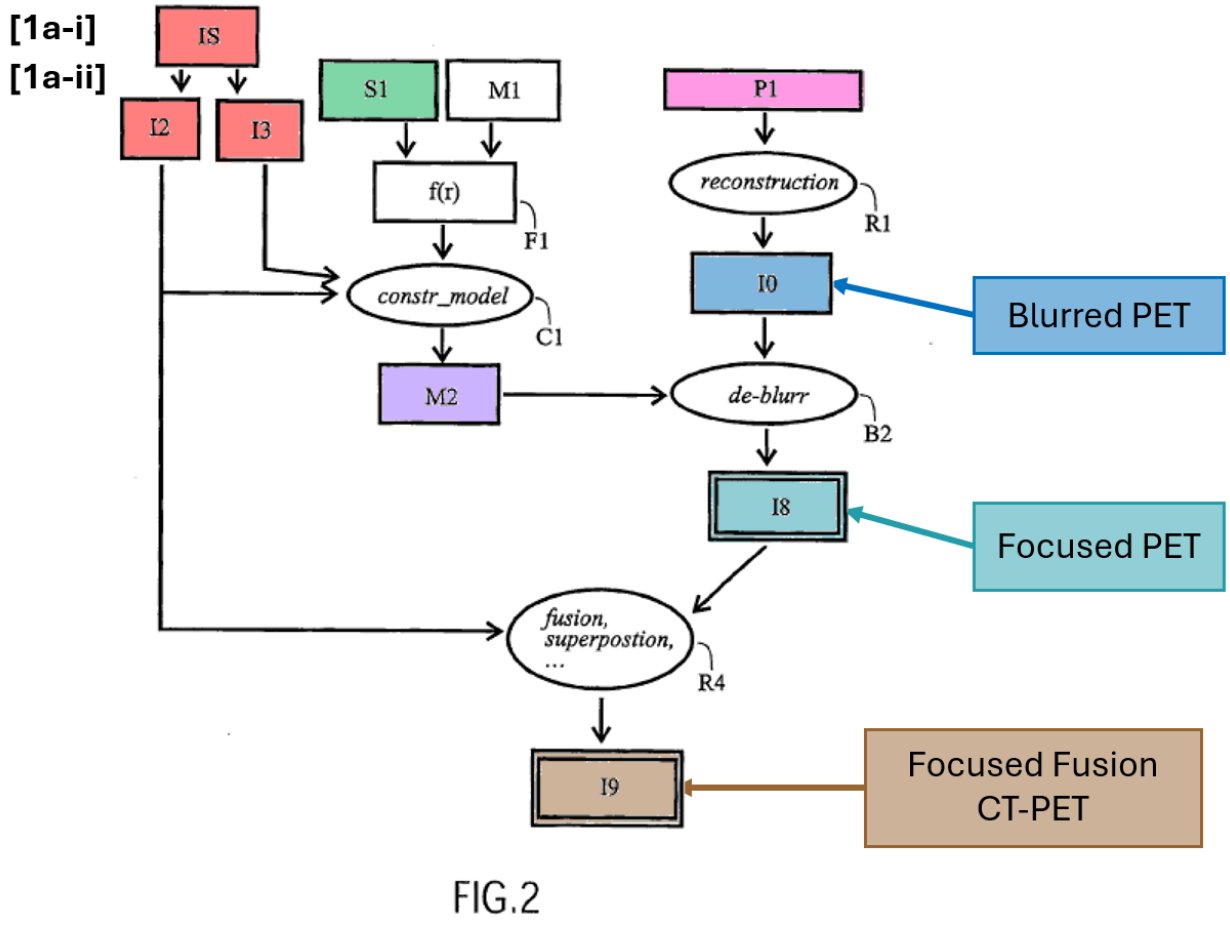
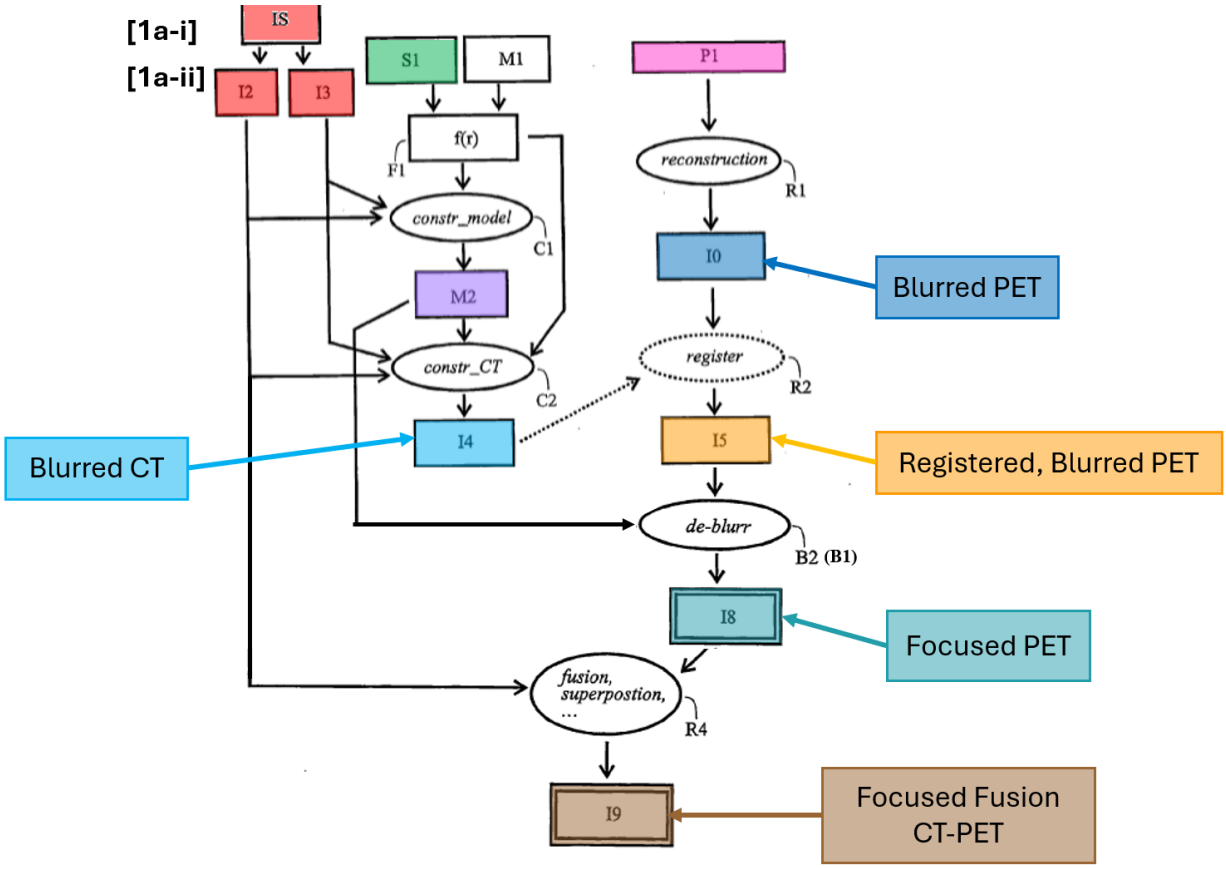


FIG.2

Weese, Fig. 2 (annotated)



Weese, modified Figs. 1-2 (annotated)

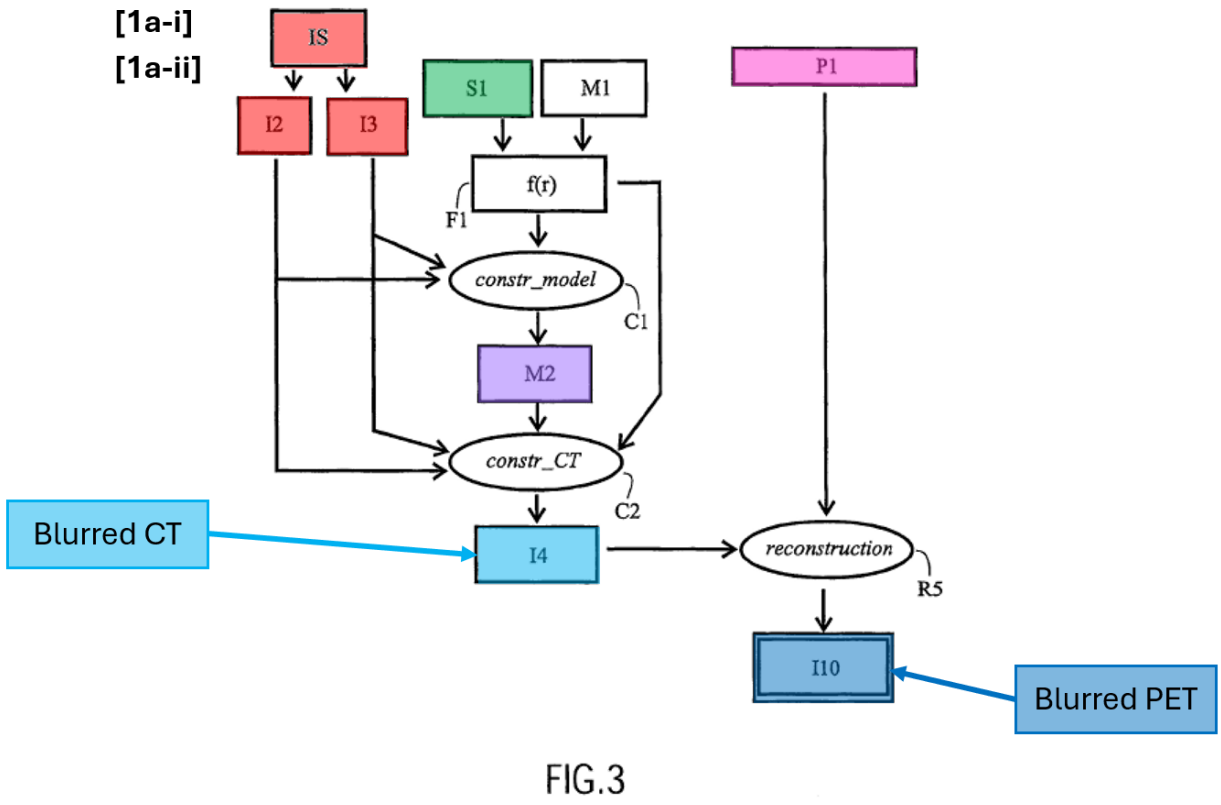


FIG.3

Weese, Fig. 3 (annotated)

4. [1a-iii] the first sensor system being independent from the first imaging technique;

[190] In my opinion, Weese discloses "the first sensor system being independent from the first imaging technique," as recited in [1a-iii].

[191] It was known at the time of the '353 patent to use independent sensor systems to monitor motion during data collection, as I explained above. *See, e.g.*, Ex-1013, 876-877 (using camera data to group PET projections); Ex-1014, 1420-21 ("gated image acquisition"); Ex-1017, 848 (1994 paper using infrared motion monitor for CT scans); § VII (TECHNOLOGICAL BACKGROUND).

[192] Weese's **acquisition unit 12** and **motion sensor 15** sense physical motion of a patient or their organs, which is an independent measurement from CT data acquisition. Weese, ¶ [0057], Fig. 6. Weese accordingly portrays these components separately from the **CT apparatus** (including radiation source S, collimator arrangement 3, and detector unit 16). Weese, ¶¶ [0053]-[0057], Fig. 6. In some embodiments, **motion sensor 15** may be sensor **S1** of Figures 1 and 2, but in an embodiment with separate and independent CT and PET systems **motion sensor 15** and sensor **S1** would be independent and different from each other. Weese, ¶¶ [0031], [0062], [0065], [0072]-[0074], [0080]; §§ X.A (Ground 1 Overview: Weese), XII.A (Ground 1 Overview: Weese), XII.B.3 ([1a-ii]). In any embodiment, **motion sensor 15** is independent from the CT X-ray detectors because it measures patient motion. Weese, ¶ [0057], Fig. 6.

[193] In Figures 1, 2, the modified figure I provided, and Figure 3, below, I added the annotation "**[1a-iii]**" to illustrate figure elements that relate to this limitation. I placed the label "**[1a-iii]**" near CT sequence **IS** and images **I2** and **I3** to represent that **motion sensor 15** sensor is used to extract **I2** and **I3** from **IS**, whether in an embodiment where the PET-CT system is combined and corresponds to **S1** or in an embodiment with a separated CT and PET systems.

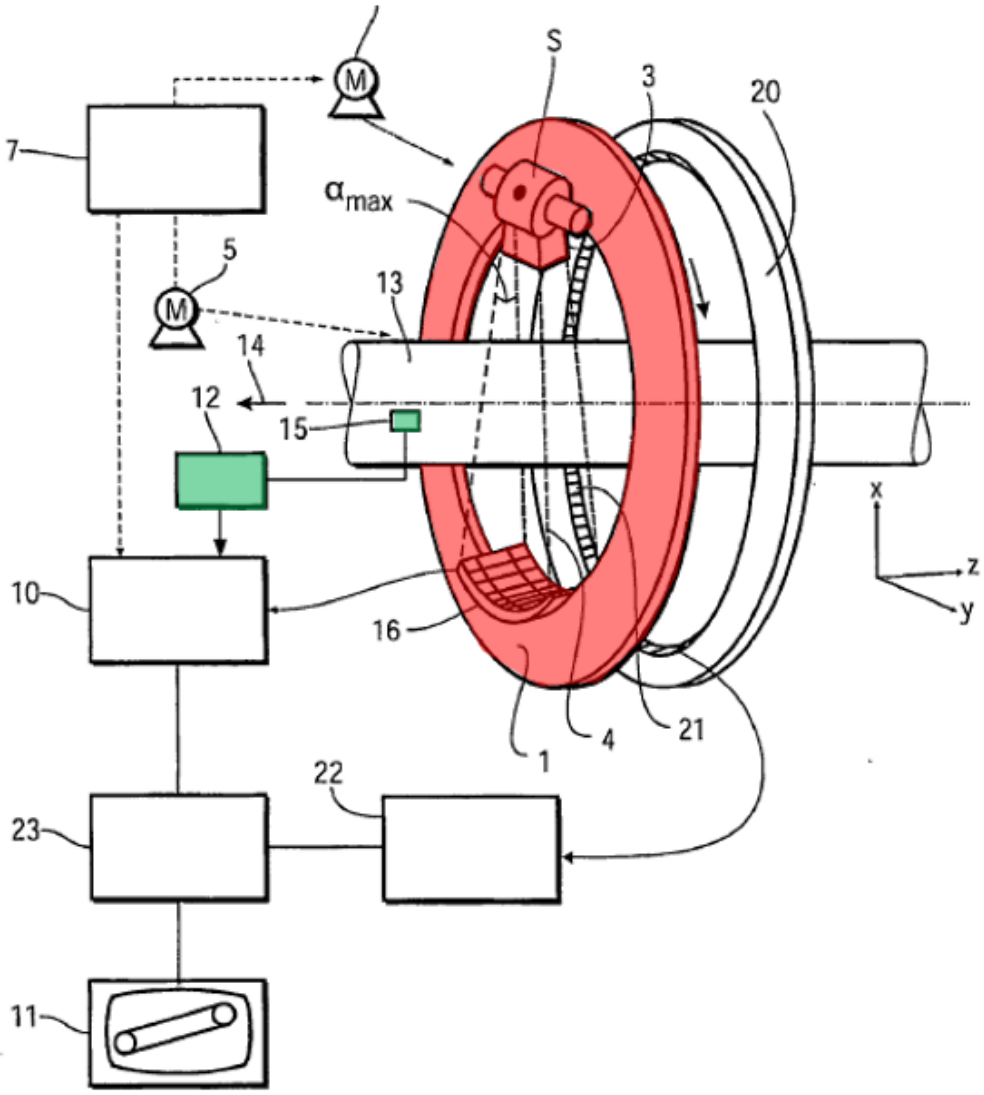


FIG.6

Weese, Fig. 6 (annotated)

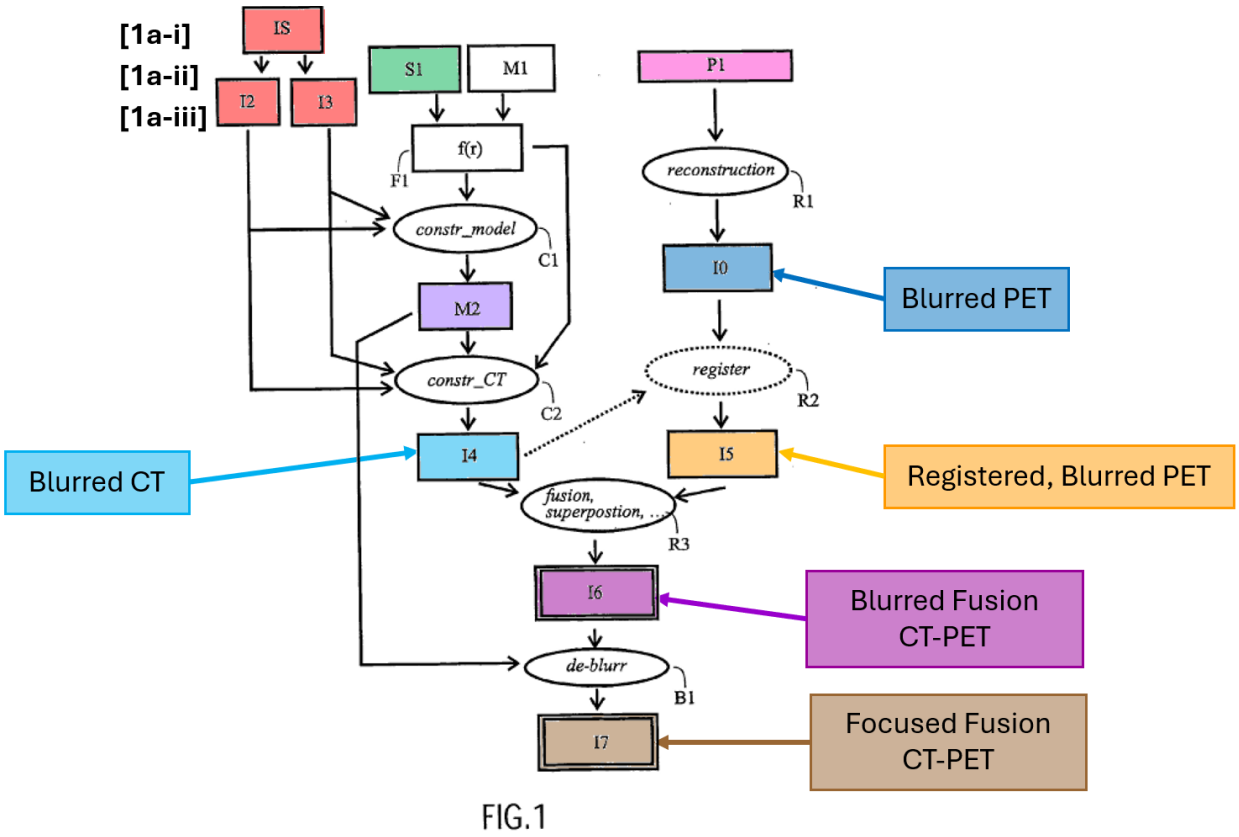


FIG.1

Weese, Fig. 1 (annotated)

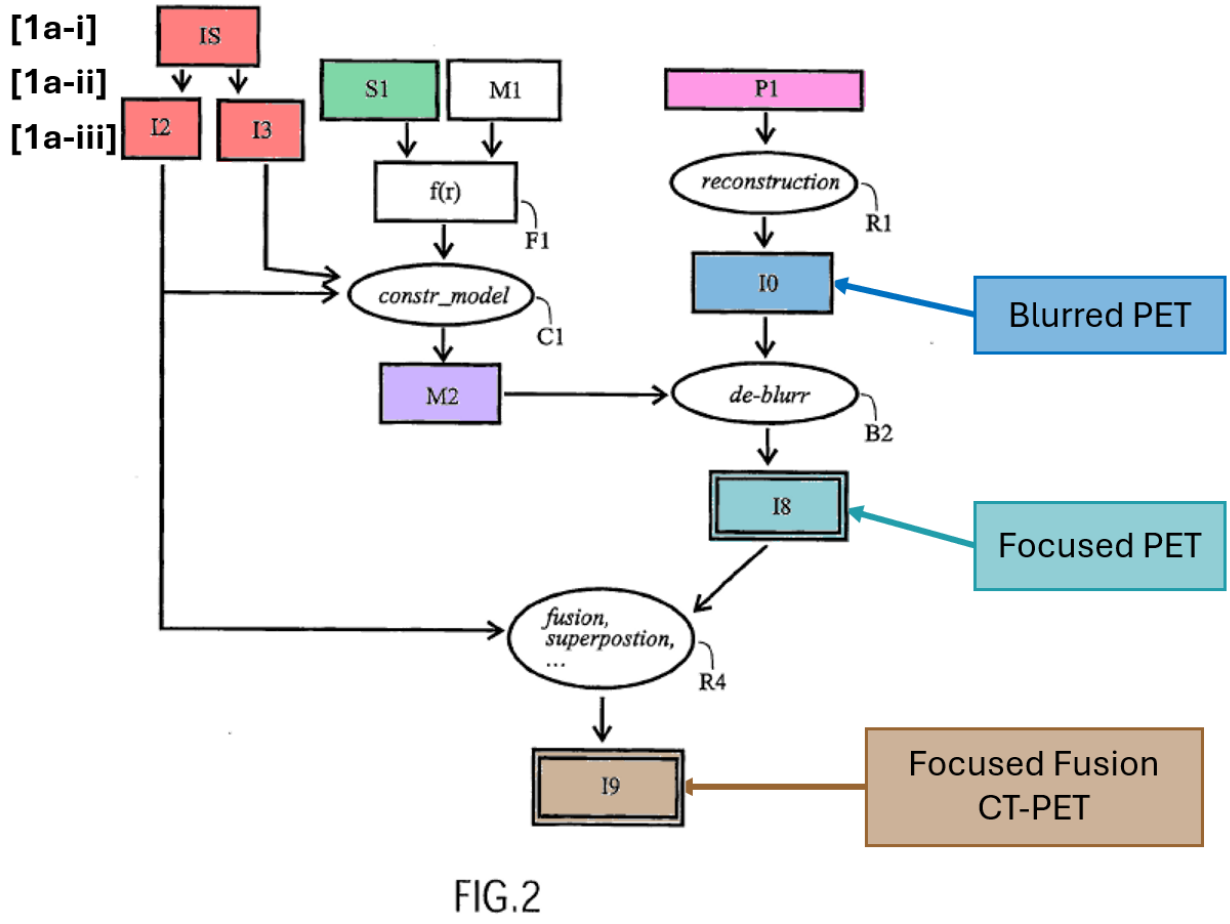
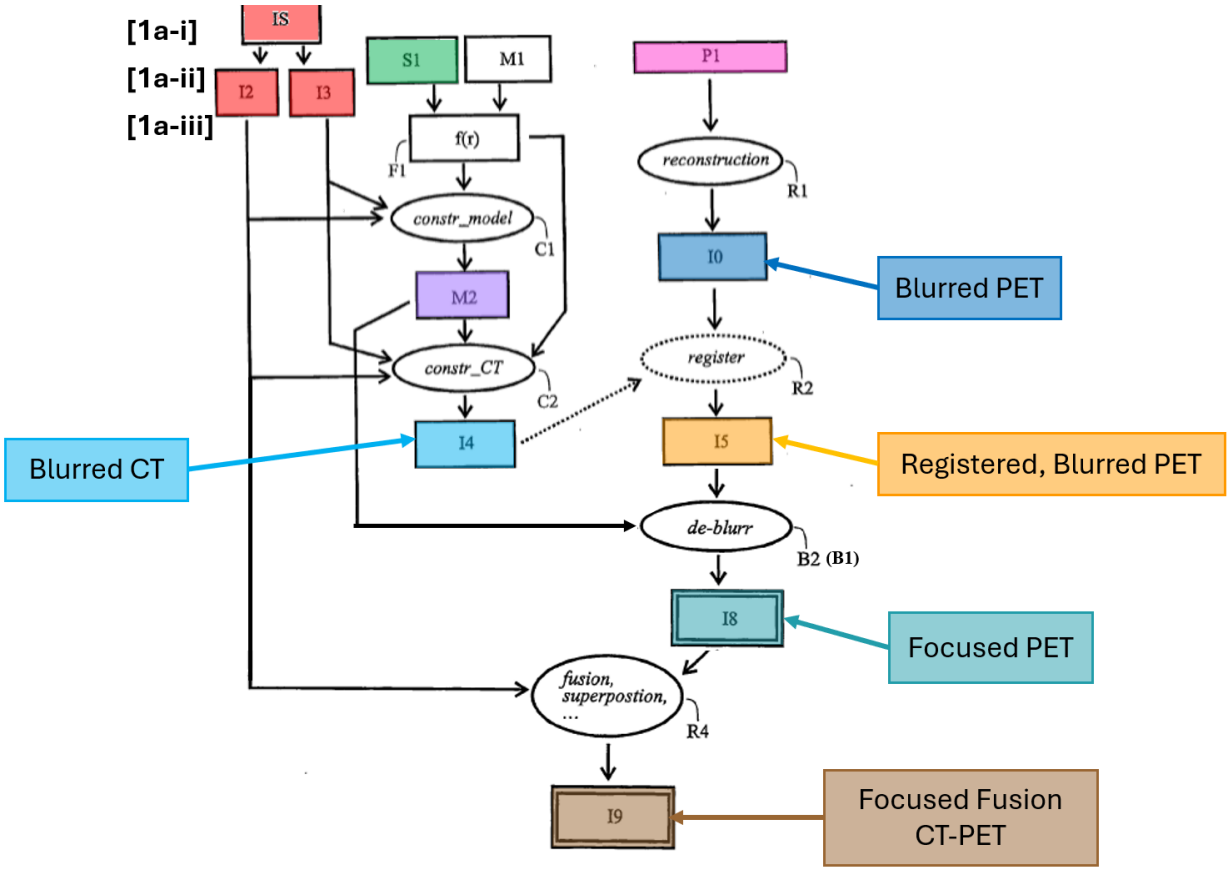


FIG.2

Weese, Fig. 2 (annotated)



Weese, modified Figs. 1-2 (annotated)

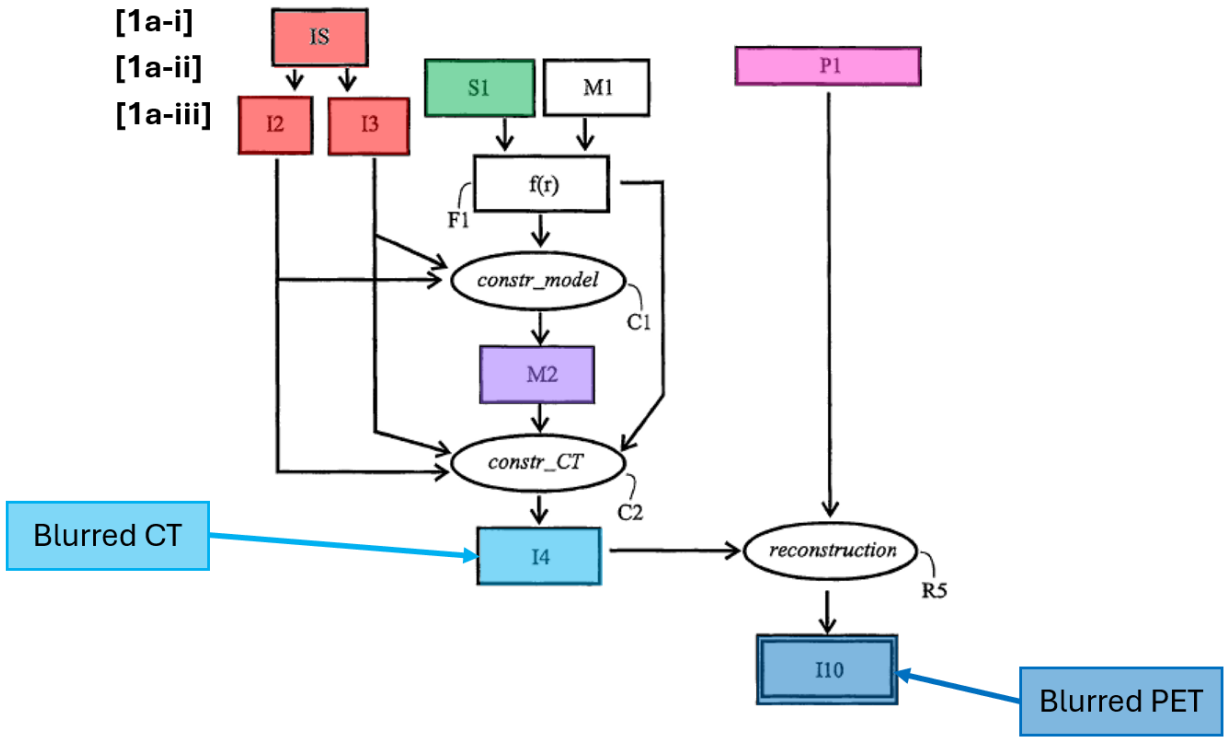


FIG.3

Weese, Fig. 3 (annotated)

5. [1b] associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

[194] In my opinion, Weese discloses "associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements," as recited in [1b].

[195] Weese teaches using **motion sensor 15** to derive a motion signal and "facilitate the selection of the measuring data that is suitable for the reconstruction" of CT images. Weese, ¶ [0057]. Here, "measuring data" refers to data acquired by the X-ray detector used to reconstruct CT images. Weese, ¶ [0055]. The motion

signal from the **motion sensor 15** enables extraction of images **I2** and **I3** from sequence **IS** at specific movement states within a breathing cycle (e.g., full inhale and exhale). Weese, ¶¶ [0053]-[0057] (acquisition), [0062] (extracting I2 and I3 from IS), [0079]; *see id.*, ¶ [0010] (two further images "represent[ing] a respective state of motion"), § XII.B.3 ([1a-ii]).

[196] Weese accordingly associates the sequence **IS** and images **I2** and **I3** (first images) with states of inhalation or exhalation (first movement states) that are determined by the motion signal (first measurements) from **motion sensor 15** in the embodiments of Figures 1, 2, the modified figure I provided above, and Figure 3. §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). In the figures below, I added the annotation "**[1b]**" to illustrate figure elements that relate to this limitation (extracting **I2** and **I3** from **IS**).

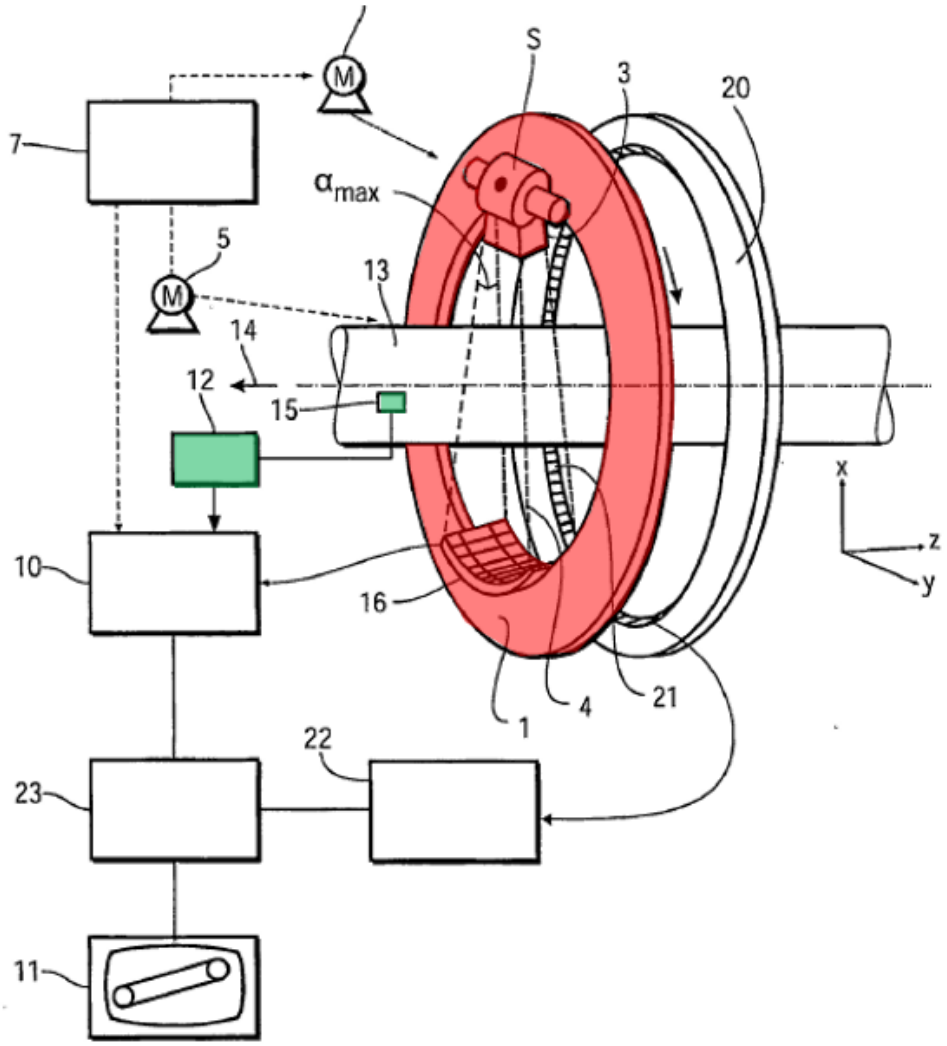


FIG.6

Weese, Fig. 6 (annotated)

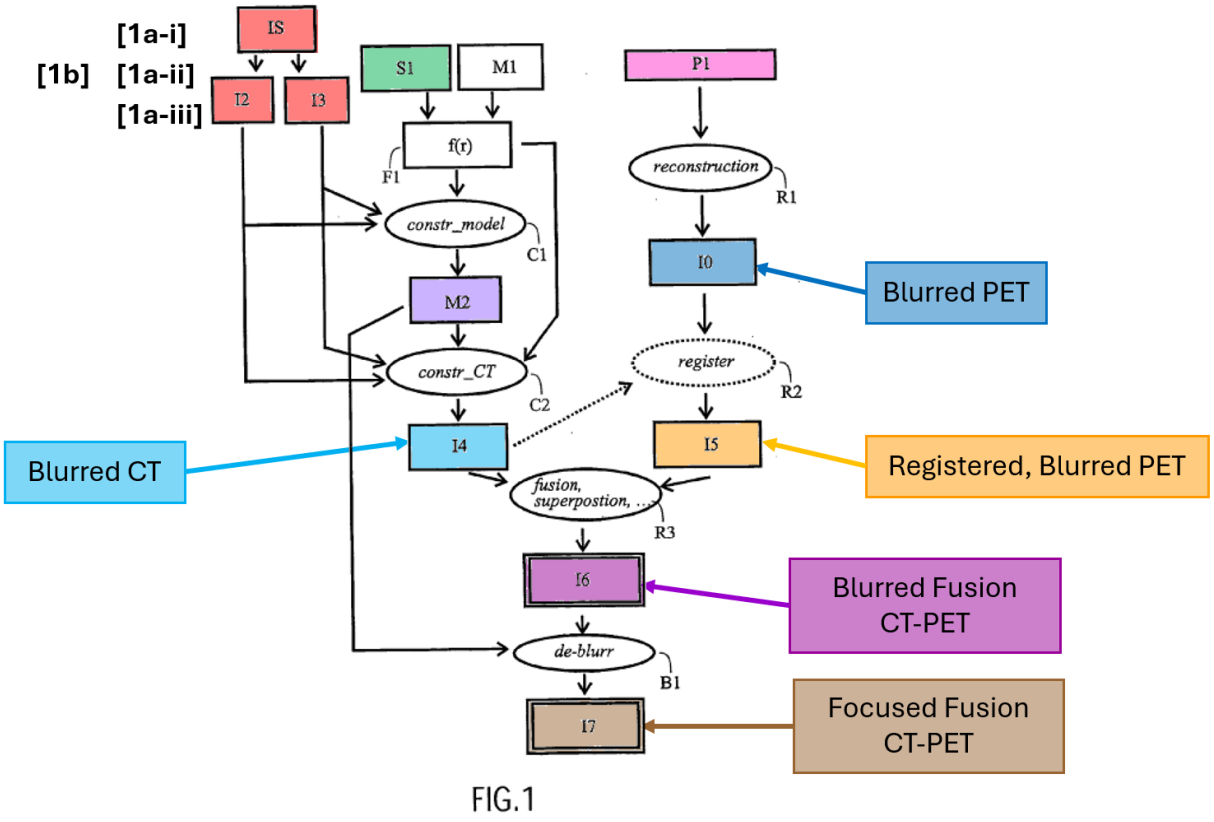


FIG.1

Weese, Fig. 1 (annotated)

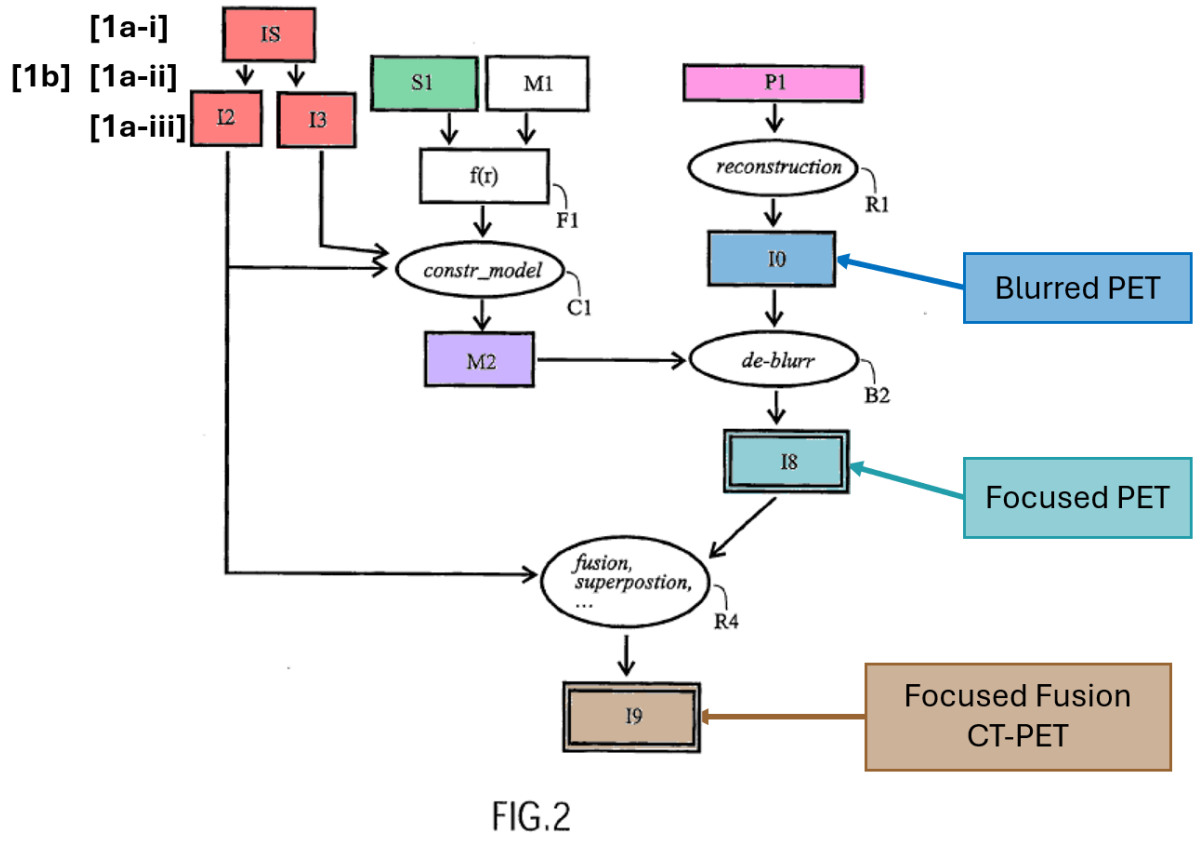
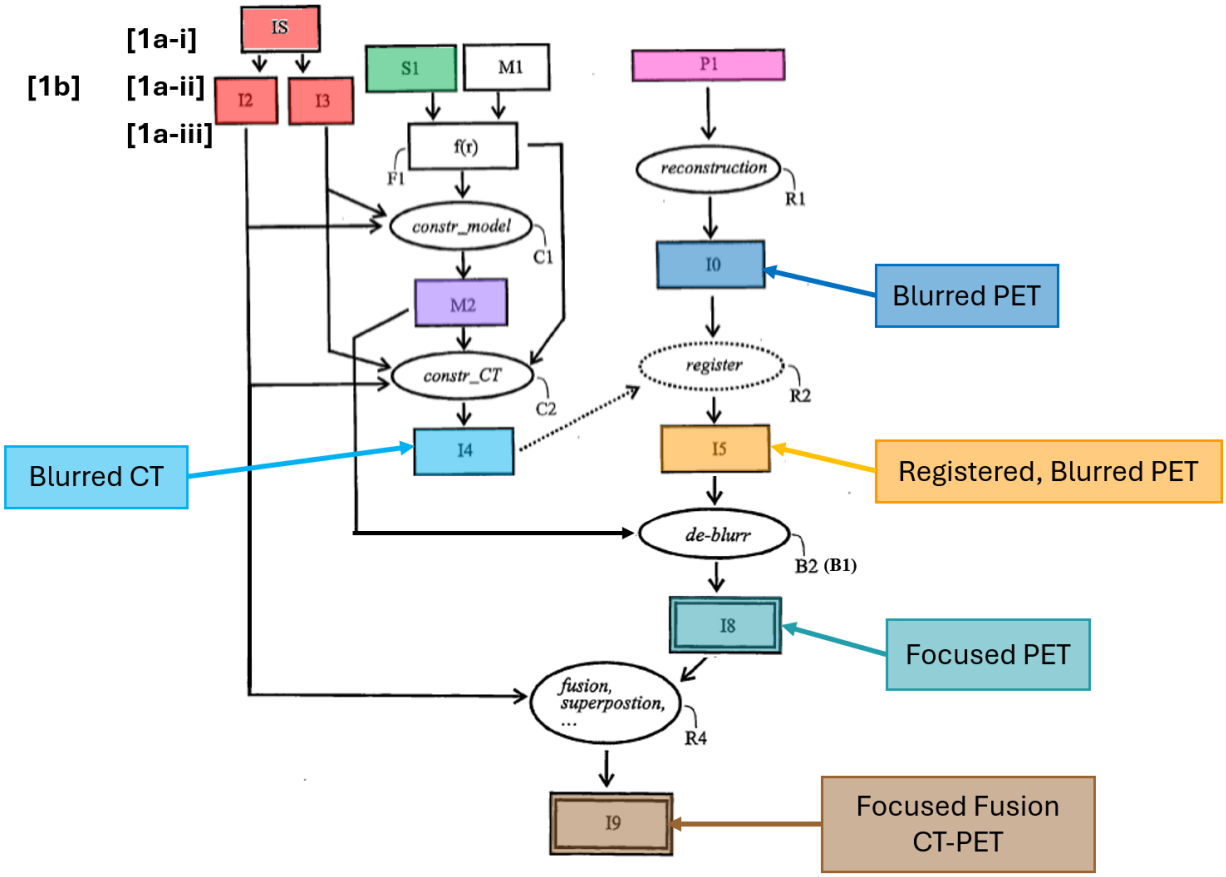


FIG.2

Weese, Fig. 2 (annotated)



Weese, modified Figs. 1-2 (annotated)

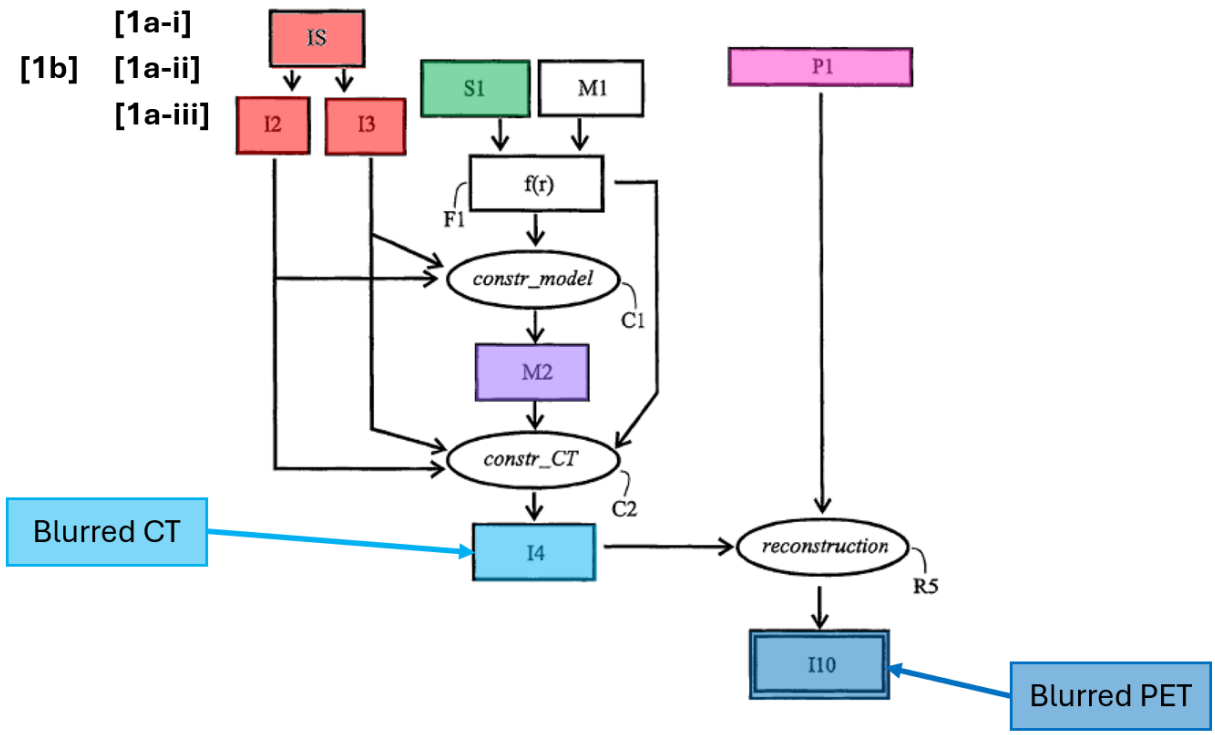


FIG.3

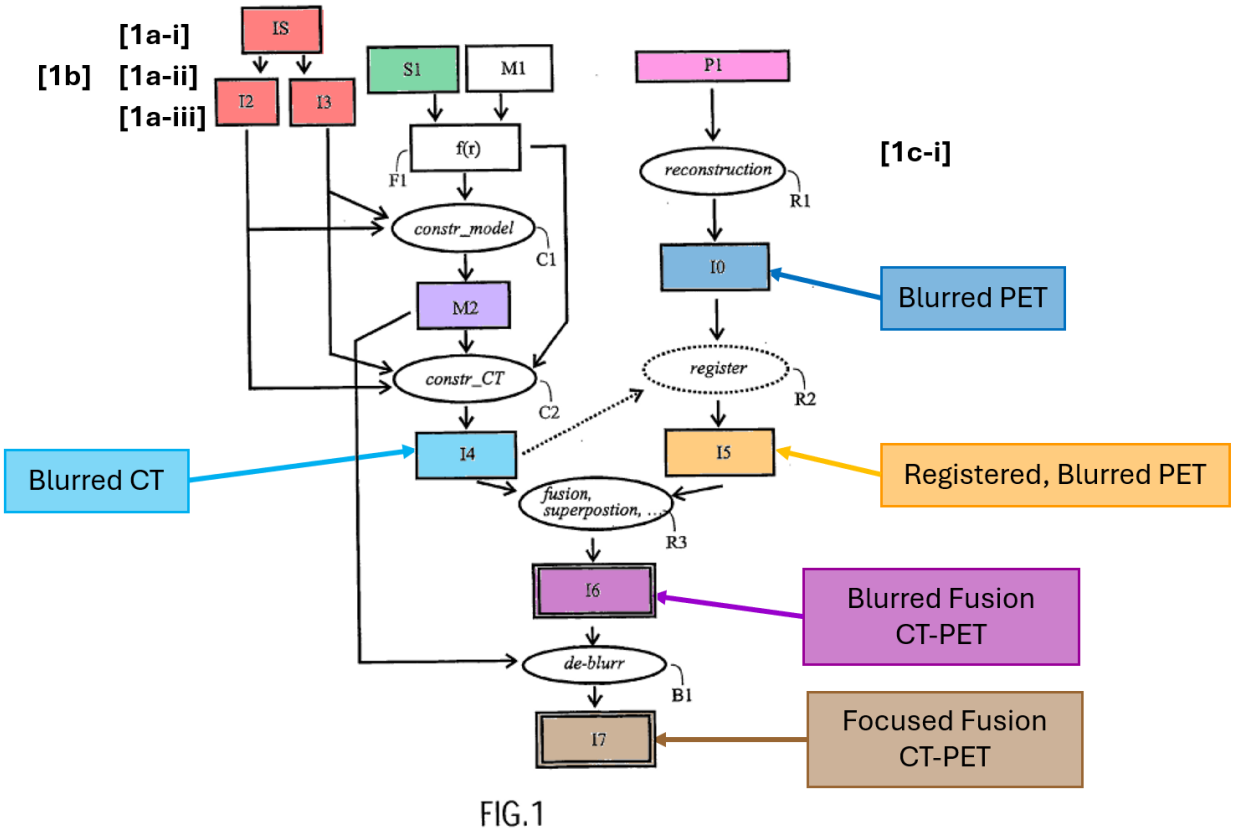
Weese, Fig. 3 (annotated)

6. [1c-i] obtaining a plurality of second images of the mobile object using a second imaging technique

[197] In my opinion, Weese discloses and renders obvious "obtaining a plurality of second images of the mobile object using a second imaging technique" as recited in [1c-i].

[198] Weese discloses collecting projections **P1** and reconstructing them (e.g., step R1) to create **PET image I0** in Figs. 1-2 or **I10** in Fig. 3. Weese, ¶¶ [0048]-[0051] (disclosing conventional PET acquisition), [0070], [0072] (separate CT and PET embodiment), [0078]-[0084], Figs. 1-3. PET is a "second

imaging technique," as recited in [1c-i], that differs from a CT imaging technique ([1a-i]). In the figures below, I added the annotation "**[1c-i]**" to illustrate figure elements that relate to this limitation (**P1**, R1, **I0**, **I10**).



Weese, Fig. 1 (annotated)

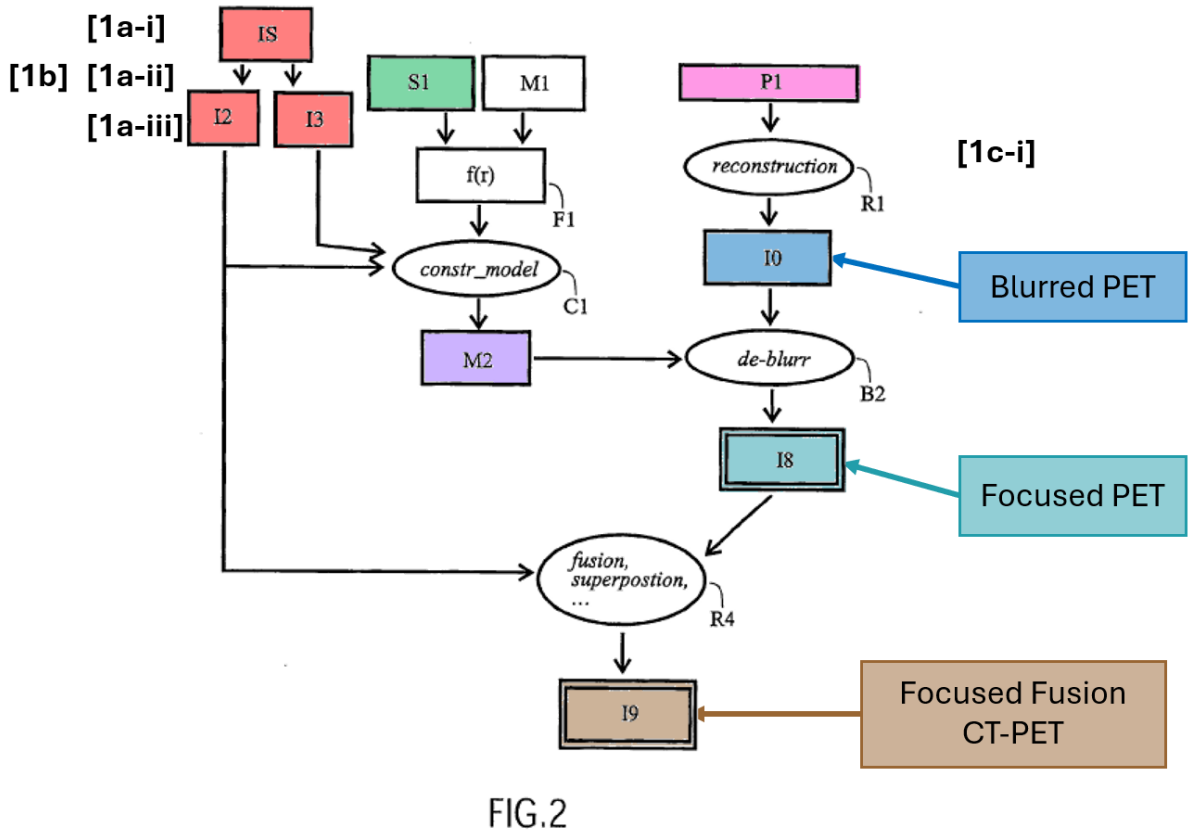
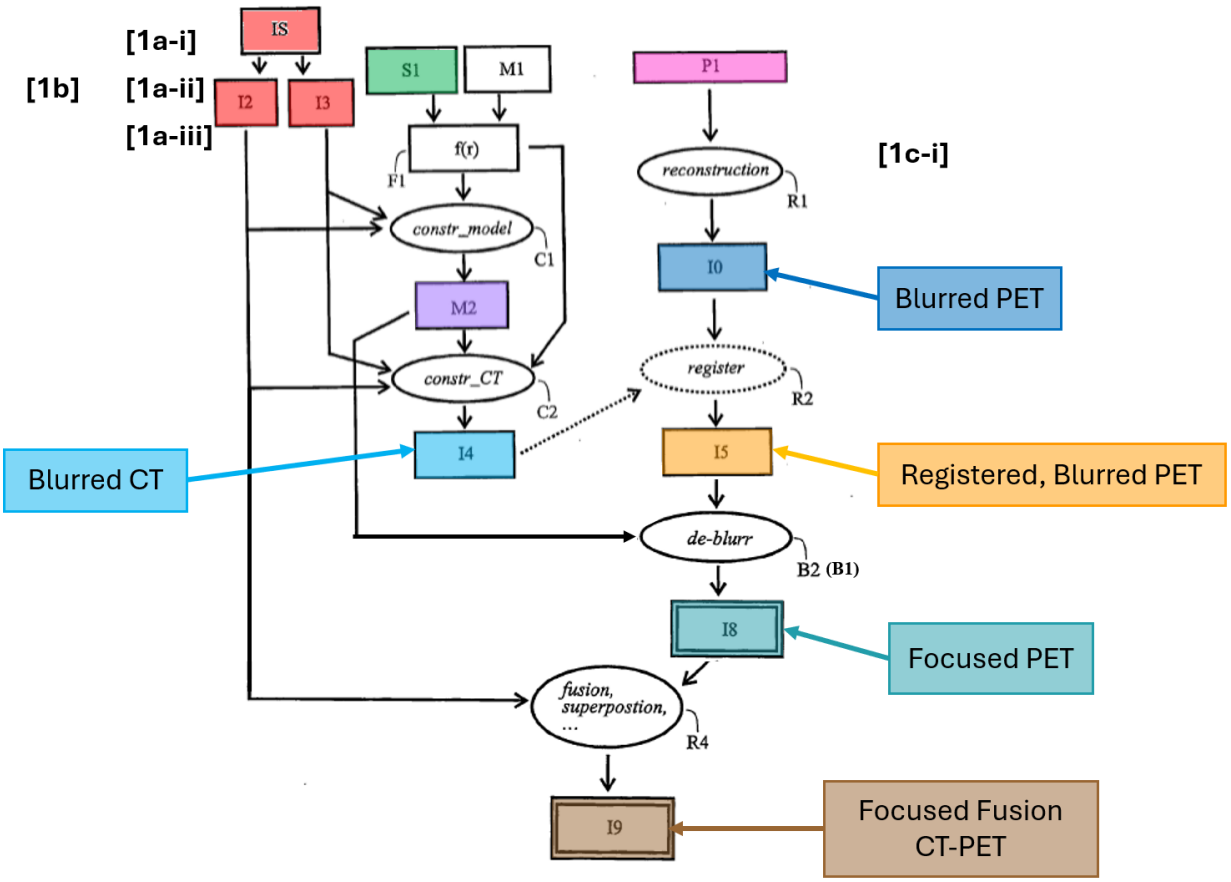


FIG.2

Weese, Fig. 2 (annotated)



Weese, modified Figs. 1-2 (annotated)

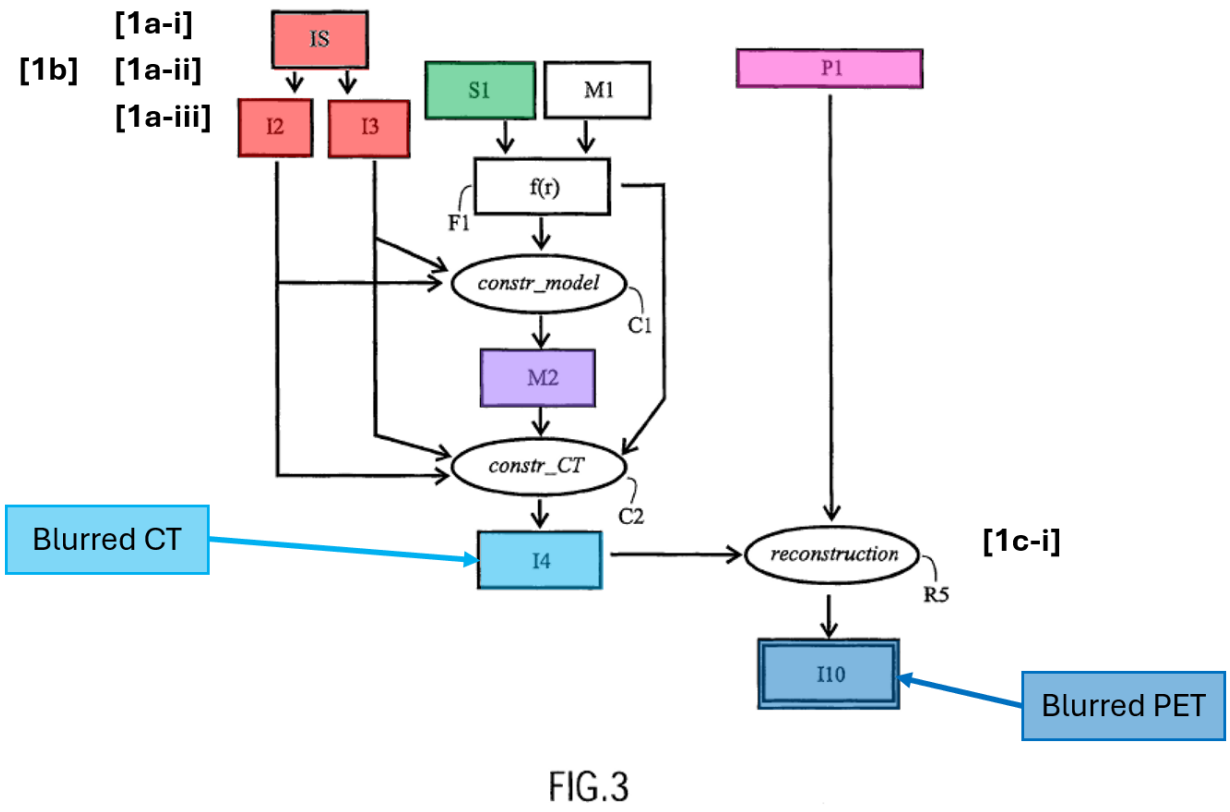


FIG.3

Weese, Fig. 3 (annotated)

[199] Weese's **PET image I0** and **I10** disclose and renders obvious a "plurality of second images" in two ways: (i) Weese discloses **I0** and **I10** are volume images in some embodiments, which discloses and renders obvious "a plurality of second images"; and (ii) **I0** and **I10** are composite, blurred PET images comprising multiple motion states corresponding to PET images focused on those multiple motion states.

a. Weese's image I0 and I10 disclose and render obvious "a plurality of second images" because they may be a "volume image"

[200] Weese attempts to solve the problem of motion artifacts in "slice images or **volume images** of a moving object." Weese, ¶ [0002]. Weese's PET images **I0** and **I10** are "volume images" in some embodiments. Weese, ¶¶ [0002], [0026], [0048], [0058], [0061], [0084] (Fig. 3 combined 'at will' with Figs. 1-2). A volume image discloses and renders obvious obtaining multiple PET slices, as recited in [1c-i].

[201] I begin by noting that Weese repeatedly describes PET images like **I0** and **I10** as conventional "volume images" formed using "known" techniques in some embodiments. For example, Weese discusses using "known . . . volume imaging" methods for CT and PET. Weese, ¶ [0026]; *see id.*, ¶ [0061]. Weese states "[t]he PET method is ***known*** from the field of nuclear medicine and is intended for the formation of slice images or ***volume images***," and "detected γ quanta forms a set of projections **P1** of the object wherefrom a slice image or ***volume image*** can be reconstructed in ***known*** manner during a subsequent reconstruction." Weese, ¶ [0048]. Weese "generates" such PET volume images from parallel rings of sensors using "***known*** algorithms." Weese, ¶ [0058].

[202] Throughout, Weese provides no specifics on how its 3D "volume images" are created. Weese, ¶¶ [0002], [0026], [0048], [0058], [0061]. Weese does

not explain how to do so, of course, because a POSITA would have been familiar with known ways to create volume images, so Weese did not need to elaborate on these admittedly known, standard techniques. *E.g.*, Weese, ¶¶ [0026] (using "known" volume imaging methods), [0048] (same), [0058] (same).

[203] In my opinion, given the background knowledge of a POSITA, it would have been understood and obvious that Weese's 3D PET "volume images" would have been based on a "plurality of second images," as recited in [1c-i].

[204] Slice-by-slice rendering of 3D volumes was a suitable known option, which teaches obtaining a "plurality of second images." It was long known to construct 3D PET and CT volume images slice-by-slice from 2D data. Tomography, by its nature, typically collects data in slices, and 3D images were known to be easily constructed by stacking such slices—i.e., from "a plurality of second images." For example, Muehllehner describes a slice-by-slice approach to reconstructing PET images. Muehllehner, Abstract ("slice-by-slice" PET approach), 1:65-2:14 (same), 12:48-60 (same), 13:18-38 (claim 1), Figs. 2, 2a, 11-13. So does Wainer. Wainer, 6:53-60. Another reference describes slice-by-slice "stacking" to construct PET volume images. Ex-1019, Abstract (stacking CT slices to form volume images), 2:18-33 (same), 5:61-6:4 (stacking 2D PET images), 6:11-25, 10:60-62, 16:62-67, Fig. 2. Yet another reference discloses "a two-dimensional, slice-by-slice approach to the display of a three-dimensional volume data set" in a combined PET-CT

apparatus. Ex-1020, ¶ [0081]. Such slice-by-slice rendering is textbook volume imaging. Ex-1008 (Bushberg textbook), 329-346 (CT slice acquisition), 360-362 (CT volume rendering from slices), 719-735 (PET slice acquisition). Hence, slice-by-slice volume imaging was the sort of suitable "known" algorithm that Weese relies on to disclose its volume imaging. *See* Weese, ¶¶ [0026] ("known" volume techniques), [0048] (same), [0058] (same).

[205] Weese takes an approach to PET imaging compatible with slice-by-slice volume rendering, and a POSITA would have had predictable success when constructing Weese's volume images from 2D slices. Weese's method creates a set of planar slices by scanning a body along an axis parallel to the gantry on which a patient lies. Weese, ¶¶ [0053]-[0058], Fig. 6. Weese's systems for creating PET images include a radiation source, gantry, computer, an evaluation unit 22 for reconstructing PET images from projections, a control unit 7, and a data processing unit 23. Weese, ¶¶ [0047]-[0051], [0058], Fig. 6. Slice-by-slice reconstruction likewise scans a body along an axis parallel to a gantry and processes PET projections using the same hardware, including a radiation source, detectors, a gantry, and a computer system. *E.g.*, Muehllehner, 3:27-58, Fig. 1; Ex-1019, 5:35-51, Fig. 3; Ex-1020, ¶¶ [0035]-[0036], [0081]. A slice-by-slice volume imaging method thus required no hardware not already disclosed in Weese—it merely would have been one well-known option to generate volume images from Weese's

projection data. Accordingly, a POSITA would have predictably and obviously used Weese's system to create 3D images from slices.

[206] In fact, another Weese patent publication directed to visualization of "volume images" from the same time describes and depicts constructing "volume images" from planar slices. Ex-1018 ("Weese-932"), ¶ [0046]. Fig. 3a.

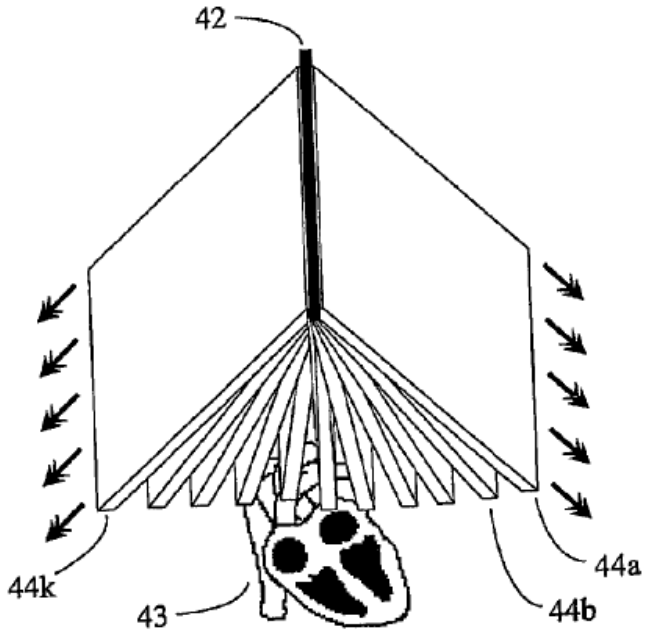


FIG.3a

Weese-932, Fig. 3a

[207] Further, although direct 3D PET data acquisition was known, slice-by-slice 2D PET data acquisition had advantages over direct 3D acquisition. Ex-1008, 725-27. For example, the Bushberg textbook from the time discusses 3D PET acquisition by removing septa from a detector system. Ex-1008, 725-27. This

textbook notes that 3D acquisition was disadvantageously limited to "low-scatter studies, such as pediatric and brain studies, and low-activity studies" because 3D methods have "greatly increased interaction rate" and a higher "number of interactions from activity outside the [field of view]." Ex-1008, 726-27. Another reference from the same time identifies the same disadvantages for 3D PET acquisition as compared to 2D approaches. Ex-1020, ¶ [0025]. A POSITA would accordingly have understood PET volume images would have been based on a plurality of 2D slice in many instances (e.g., PET thoracic images).

b. Weese's image I0 and I10 disclose and render obvious "a plurality of second images" because Weese discloses a PET image is a "superposed . . . image" of "several states of motion"

[208] Weese's image **I0** also discloses and renders obvious "a plurality of second images" because Weese discloses such a PET image is a "superposed . . . image" encompassing "several states of motion" when discussing "focusing" an image to remove motion artifacts:

> Generally speaking, the object appears to be unsharp to a viewer because ***several states of motion of the object motion are represented in superposed form in an image***. For the focusing of an object represented with motional unsharpness, the object is represented in only one state of

> motion of the motion in that the ***superposition with the remaining states of motion*** is eliminated.

Weese, ¶ [0022]. Weese makes this same point a second time, stating: "PET image I0 also constitutes a superposition of all states of motion . . . ." Weese, ¶ [0070]. Accordingly, Weese's **I0** are **I10** are examples of a "superposed" image because they are reconstructed PET images containing motion artifacts from projections collected over a long exposure. *E.g.*, Weese, ¶¶ [0004] (motion artifacts in PET as motivation for Weese's invention), [0005]-[0008] (reconstructing "first image" from projections), [0022] ("superposed"), [0037] (PET and CT as first and further images), [0047]-[0052] (PET as first image with motion artifacts and CT images as "further images" to correct motion, noting projections may take up to an hour to collect), [0083], Figs. 1-3; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Overview of Ground 1: Weese), above.

[209] A POSITA would have been familiar with Weese's explanation that reconstructed PET images like **I0** and **I10** are superpositions of many PET images. Weese, ¶¶ [0022], [0070]. One reference provides a similar explanation, stating "[d]uring the scan, the patient breathes normally and the resulting PET image is ***an integration*** over the respiratory and cardiac cycles." Ex-1017, ¶ [0109]. Further, PET gating techniques were well known, and such techniques rely on this concept

to group projections (e.g., P1) into time bins associated with different motion states such as different phases of breathing or cardiac cycle. *E.g.*, Wainer, 3:33-60 (disclosing gating methods for "body rhythms"); Ex-1008, 696-699 (Bushberg textbook description of gating); § VII (TECHNOLOGICAL BACKGROUND). And the '353 patent itself specifically recognizes that ordinary reconstructed PET images are a superposition of many PET images and use gating to distinguish them. Ex-1001, 2:53-3:48 (deriving multiple images Et5 by gating one set of projections Et2 to different motion states), Fig. 1 (same).

[210] The concept that PET images like **I0** are a superposition of many images is consistent with well-known gating methods in medical imaging. The literature contained many examples of gating techniques, as I have explained at length. § VII (TECHNOLOGICAL BACKGROUND). A textbook described this general approach for nuclear medicine (e.g., PET) to correct cardiac motion artifacts, including in ways applicable to CT and PET scans. Ex-1008 (Bushberg textbook), 696-699. The figure below, for example, shows images grouped based on the projection timing and the cardiac cycle. Ex-1008, 698. This is equally applicable to respiration. *E.g.*, Ex-1013 (respiratory gated PET); Ex-1014 (same). A set of projections collected at multiple movement states leads to a fused, blurred image. By grouping projections based on the phase of the patient motion, these superposed images are separated. Thus, gating shows a POSITA would have understood that

PET images reconstructed without gating (like Weese's **I0**), are superposed images of all phases of a repetitive cycle.

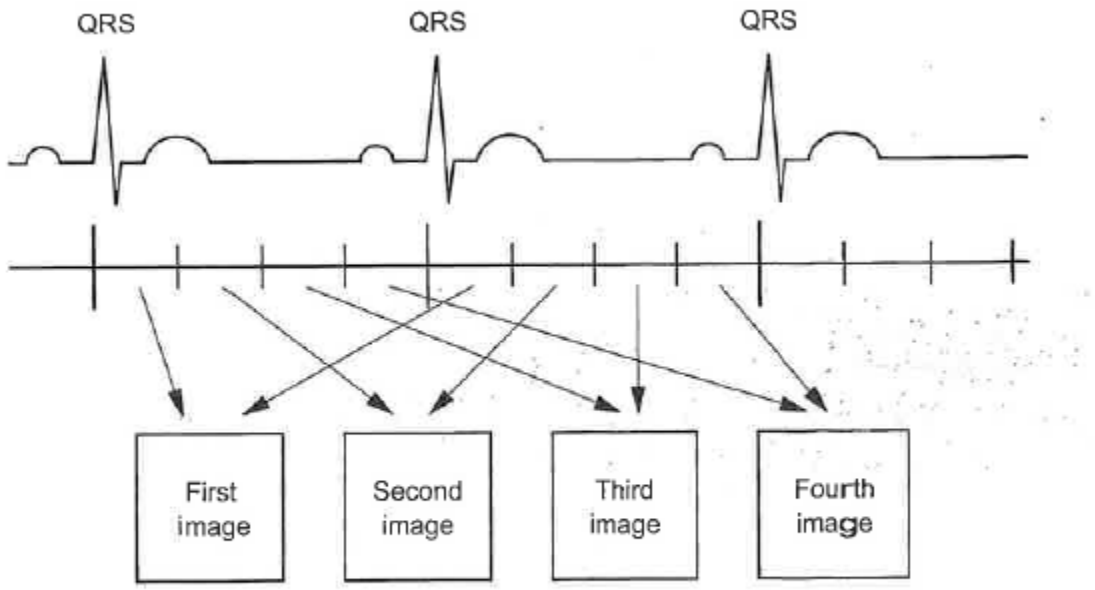


FIGURE 21-22. Acquisition of a gated cardiac image sequence. Only four images are shown here. Sixteen to 24 images are typically acquired.

Ex-1008, 698 (Figure 21-22) (grouping projections into different phases of cardiac cycle)

[211] Accordingly, in view of Weese's repeated, explicit disclosure that its reconstructed PET images are "superposed" images comprising various PET images corresponding to different phases of the breathing cycle, which was a well understood concept, a POSITA would have understood **I0** and **I10** discloses and renders obvious a "plurality of second images." Weese, ¶¶ [0022], [0070]; *see supra*.

7. [1c-ii] while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system

[212] In my opinion, Weese discloses and renders obvious "obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system," as recited in [1c-ii], while "obtaining a plurality of first images of the mobile object using a first imaging technique" as recited in [1c-i].

[213] It was known at the time of the '353 patent to use sensor systems to monitor motion during CT and PET data collection, as I explained above. *See* Section VII (TECHNOLOGICAL BACKGROUND). The '353 patent did not invent that approach.

[214] For its combination CT/PET apparatus, Weese discloses using "sensor **S1**" so "motion is determined ***during the acquisitions of the PET projections P1***," i.e., "obtaining a plurality of second measurements corresponding to movements of the mobile object" while obtaining the second images. Weese, ¶¶ [0065], [0083], Figs. 1-3; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese), XII.B.3 ([1a-ii]). This process reads onto [1c-ii] whether **motion sensor 15** used to extract **I2** and **I3** from **IS** is the same as sensor **S1** or different from **S1**. I note that the claims do not require that the second sensor measurements come from a different sensor. For example, claim 11, which depends from claim 1,

further limits claim 1 by requiring "the first sensor system is different from the second sensor system," which demonstrates that [1c-ii] encompasses methods where the claimed first and second measurements are obtained from the same sensor system.

[215] In Weese's embodiments where the PET apparatus was separate from the CT system, this sensor **S1** would have been in a different location and thus would have been a "second sensor system" different from the first sensor system (**motion sensor 15**) associated with the CT system. Weese, ¶¶ [0065], [0072]-[0074]; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese), XII.B.3 ([1a-ii]). As I previously explained (XII.B.3, ([1a-i])), Weese emphasizes the need for sensors to better align CT and PET images by matching corresponding motion states in combined CT-PET systems. *See* Weese, ¶¶ [0031], [0057], [0062], [0065], [0072]-[0074], [0080]. A POSITA would have understood the need to match motion states is even ***greater*** in separated CT and PET systems than combined systems owing to alignment variables introduced by moving from one instrument to the other. Weese, ¶¶ [0072]-[0073] (difficulty of superimposing motivating use of registration techniques for separated CT and PET systems); Ex-1008, 735 (discussing problems merging images from different instruments in different rooms); Ex-1009, 1609-1610 (problem of "wildly different" conditions for CT and PET images taken separately); Ex-1010 (motion artifacts in CT images).

[216] In either a combined PET-CT or separated PET and CT systems, Weese teaches to use data from sensor **S1**, along with images **I2** and **I3**, to construct the motion model **M2**, which facilitates comparison of CT and PET images. Weese, ¶¶ [0063], [0065] (using **S1** to measure "actual motion" during PET and create **M2**), [0069] (blurred CT image **I4** based on **M2**), [0071], [0078]-[0080], [0083], Figs. 1-3; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). Weese thus discloses and renders obvious "while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system," as recited in [1c-ii]. Below, for the embodiments of Figures 1, 2, the modified figure I provided, and Figure 3, I added the annotation "**[1c-ii]**" to illustrate that **S1** relates to this limitation.

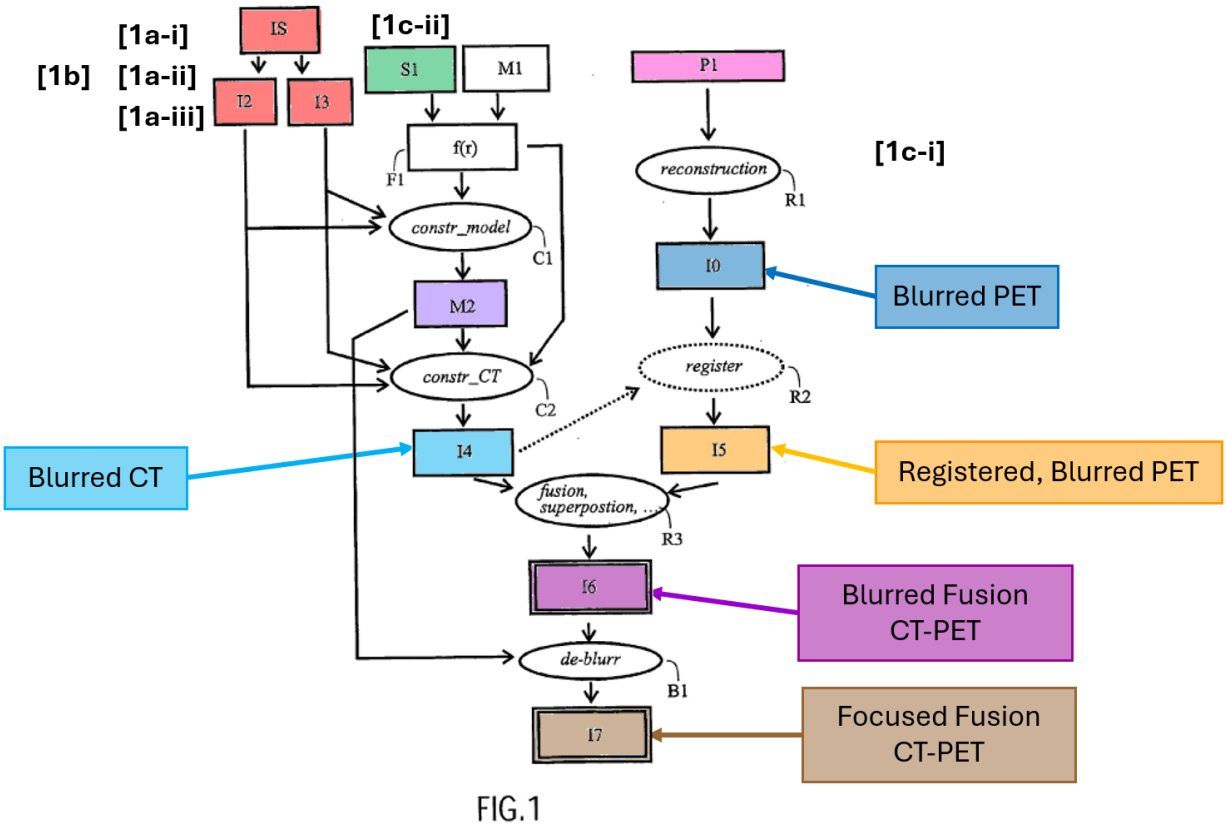


FIG.1

Weese, Fig. 1 (annotated)

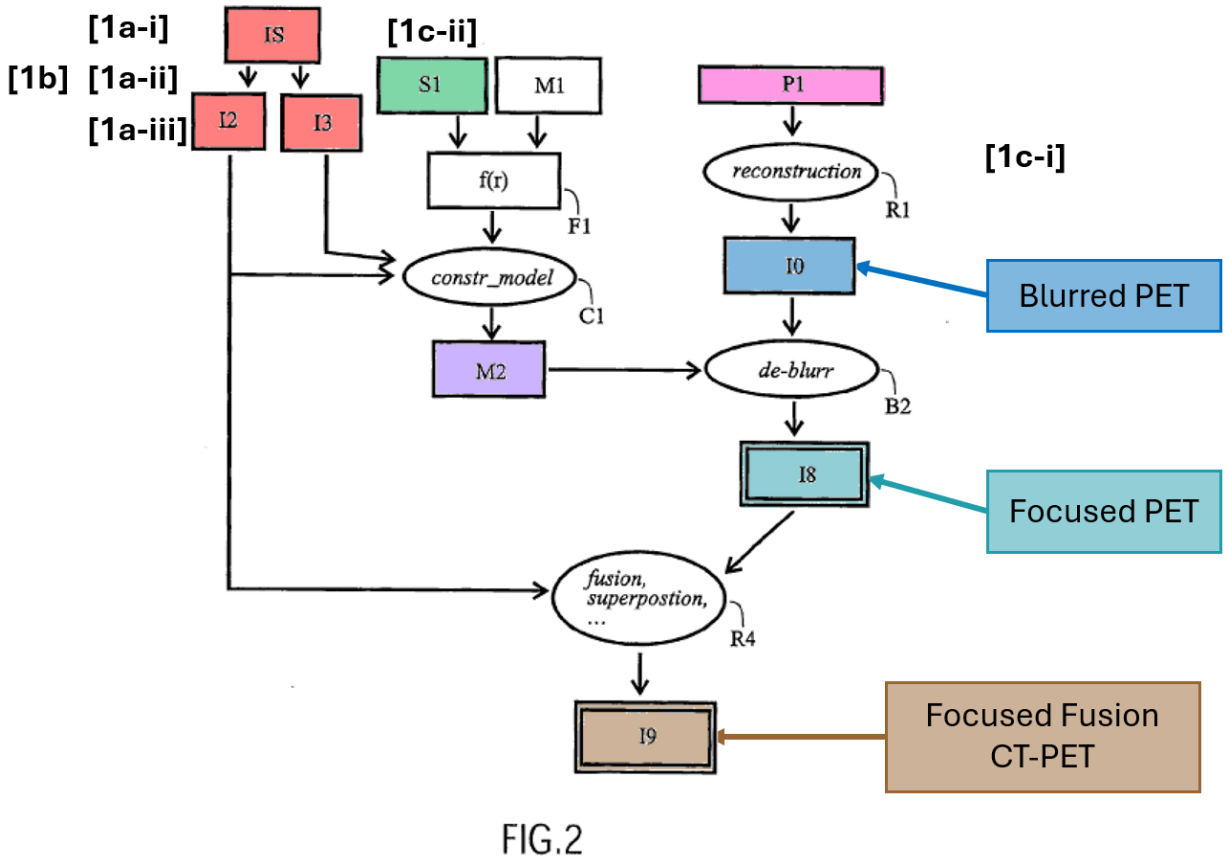
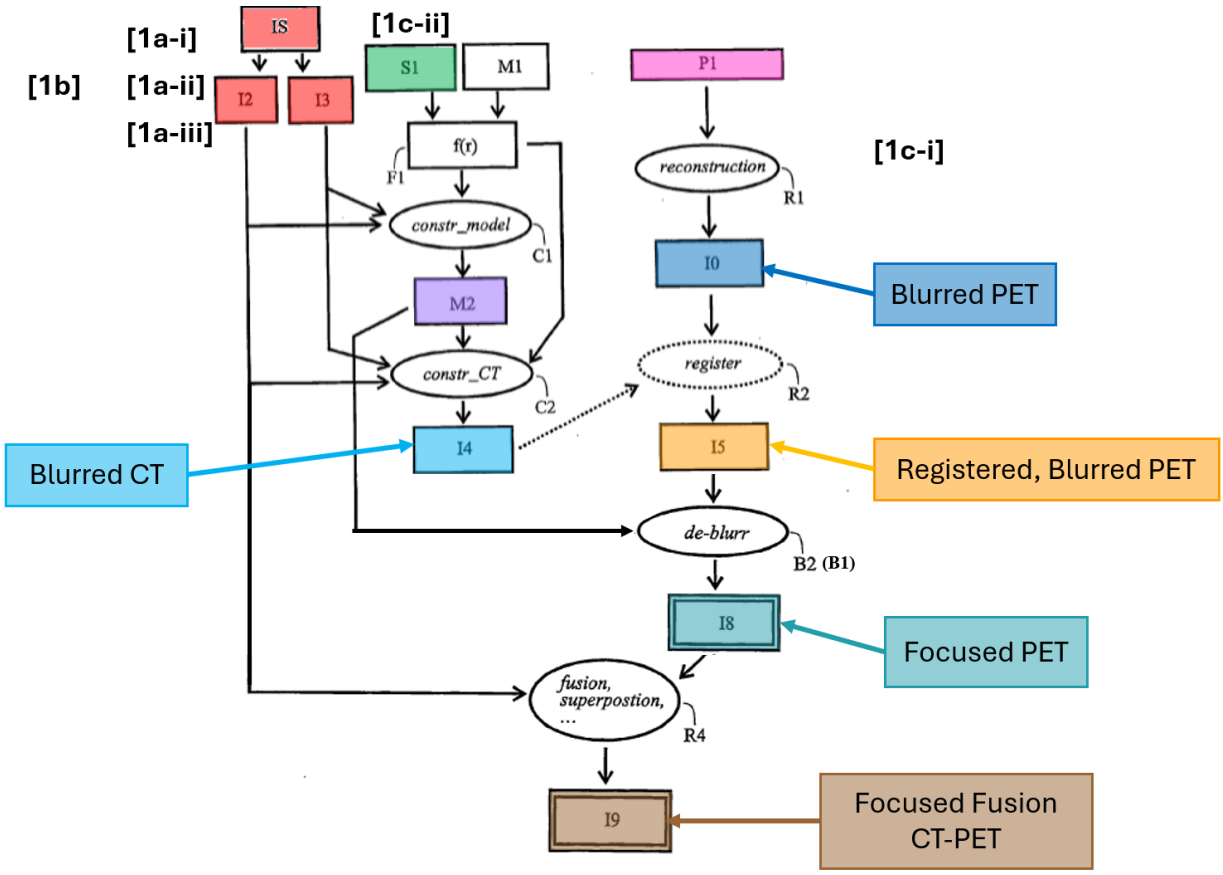


FIG.2

Wese, Fig. 2 (annotated)



Weese, modified Figs. 1-2 (annotated)

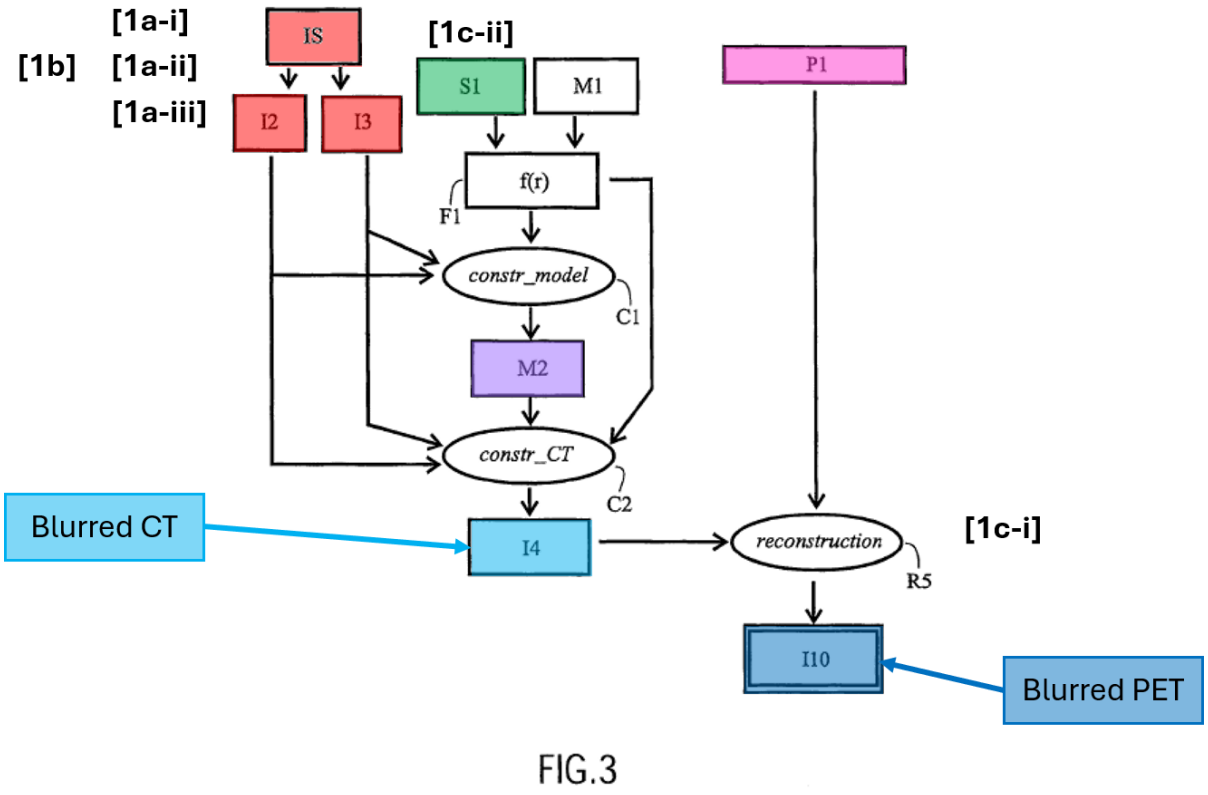


FIG.3

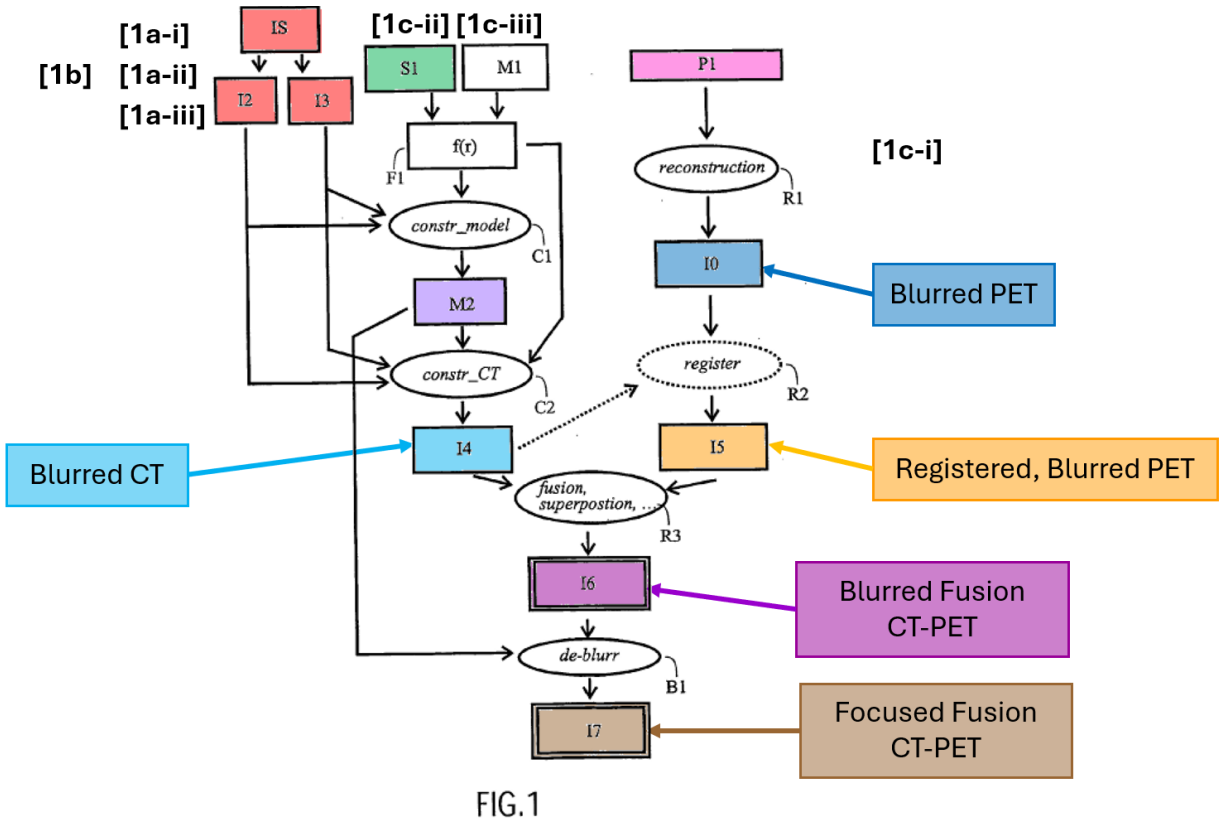
Weese, Fig. 3 (annotated)

8. [1c-iii] the second sensor system being independent from the second imaging technique;

[217] In my opinion, Weese discloses "the second sensor system being independent from the second imaging technique," as recited in [1c-iii].

[218] Weese's "sensor **S1**" is a "motion sensor provided on the patient" to measure respiratory motion and thus independent from the PET detection system. Weese, ¶ [0065]. Sensor **S1** collects motion data, not PET data. Weese, ¶ [0065]. The same holds true in embodiments where the PET system is independent from the CT system. Weese, ¶¶ [0065], [0072]-[0074], [0080]; §§ X.A (Overview of Weese

(U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese); XII.B.7 ([1c-ii]). Weese thus discloses "the second sensor system being independent from the second imaging technique" as recited in [1c-iii]. Below, for the embodiments of Figures 1, 2, the modified figure I provided, and Figure 3, I added the annotation "**[1c-iii]**" to illustrate that **S1** relates to this limitation.



Weese, Fig. 1 (annotated)

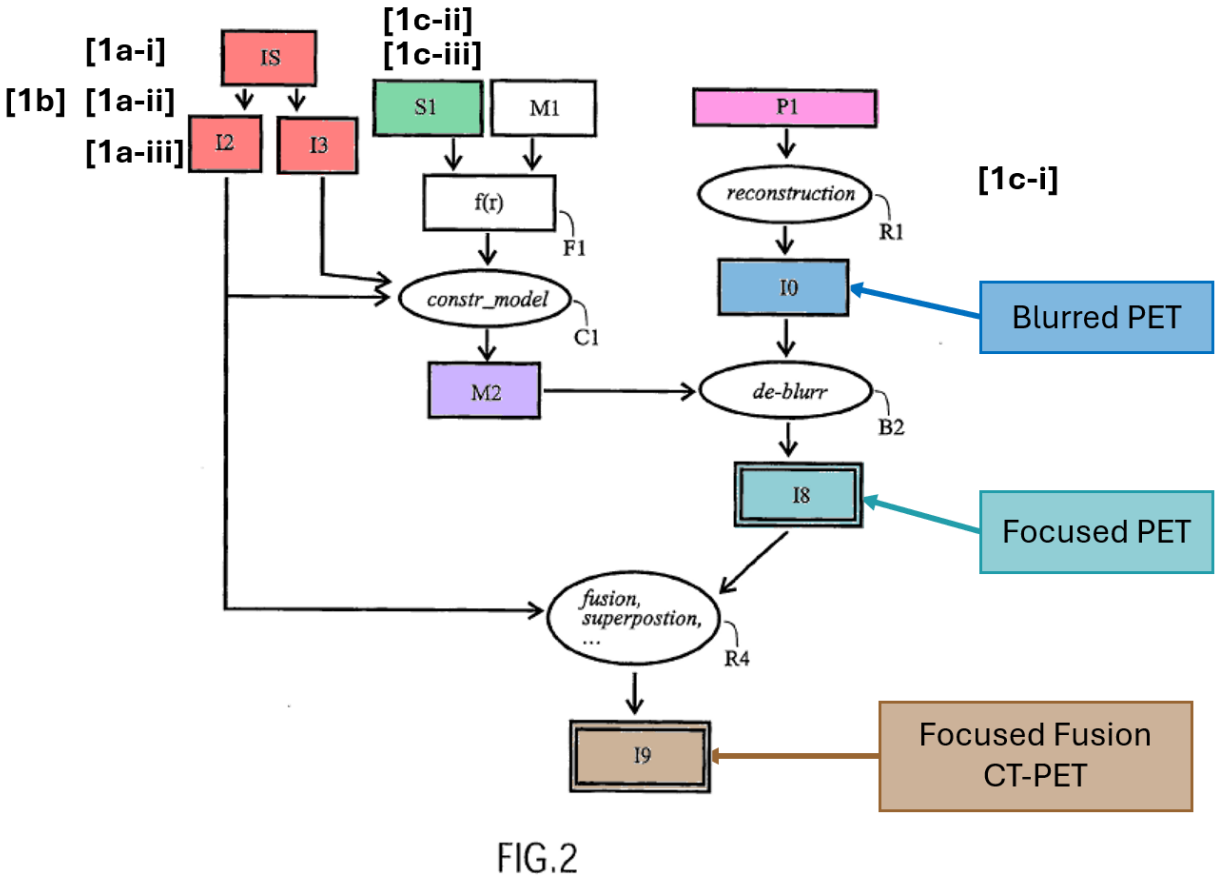
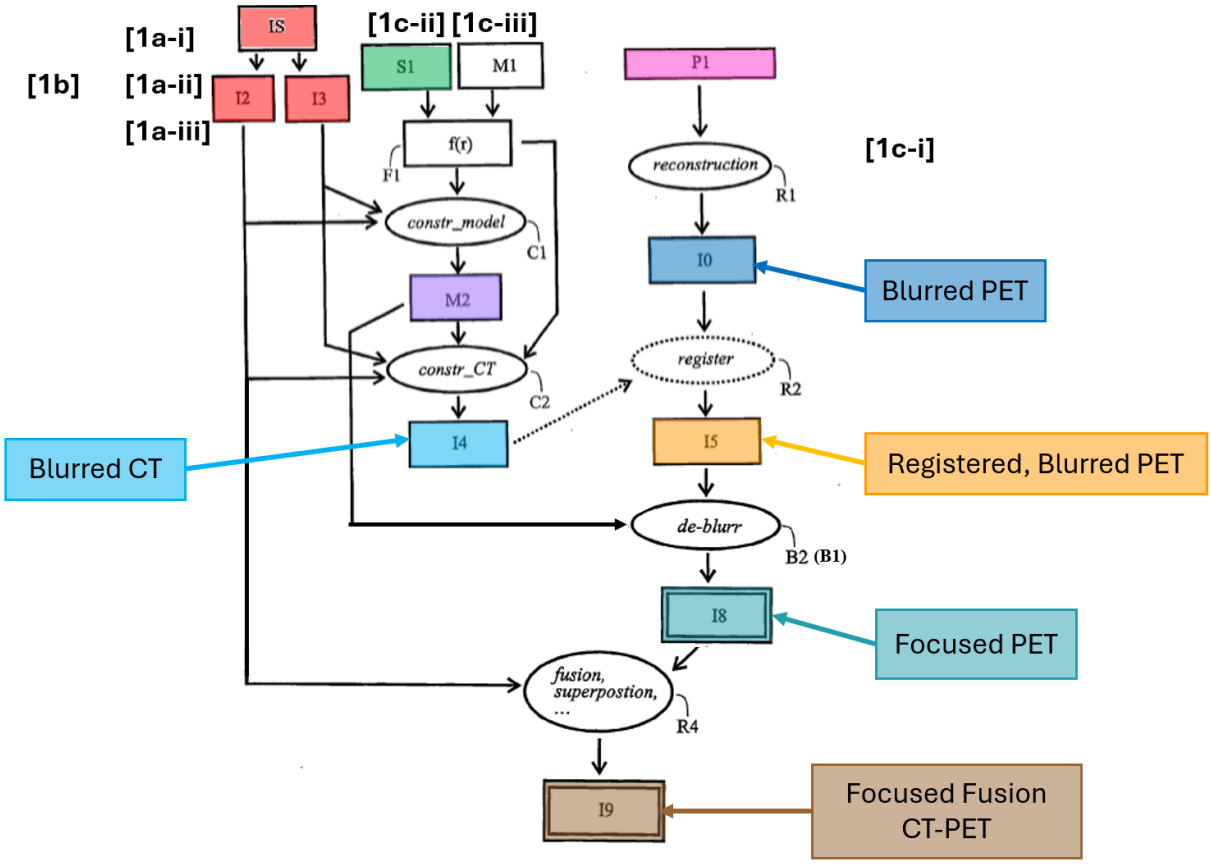


FIG.2

Weese, Fig. 2 (annotated)



Weese, Figs. 1-2 (annotated)

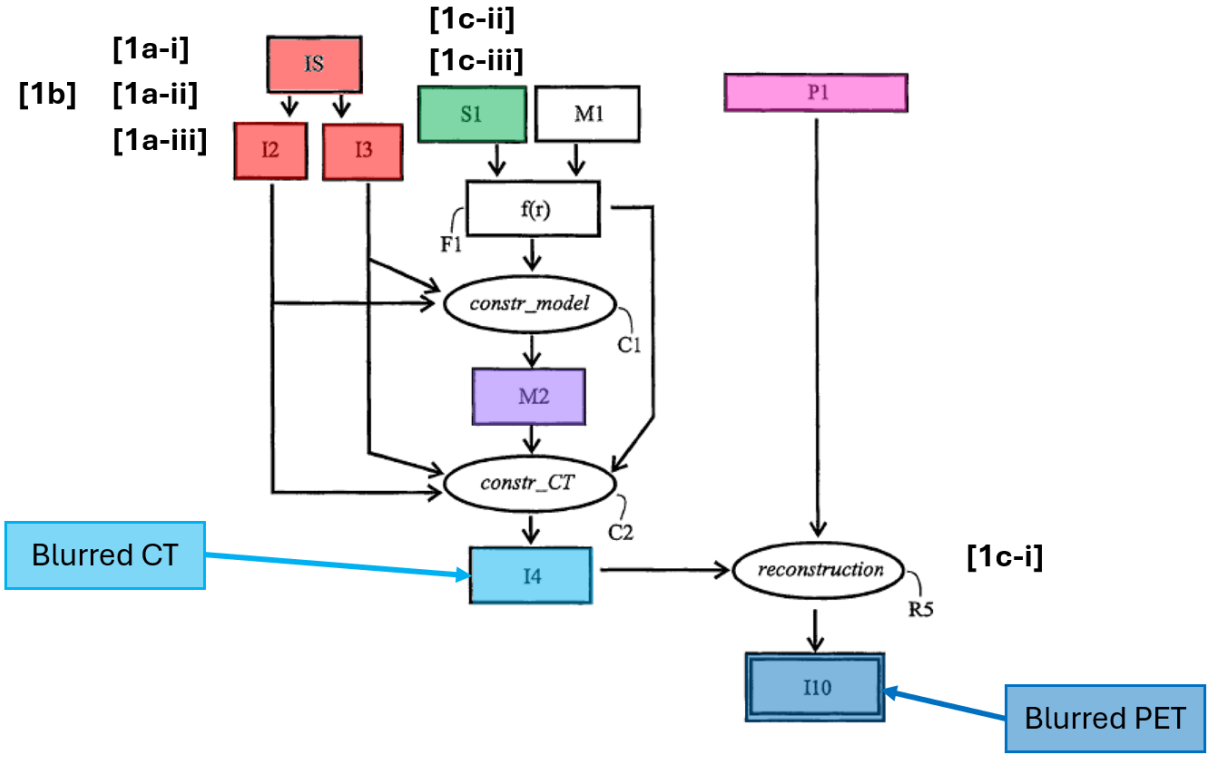


FIG.3

Weese, Fig. 3 (annotated)

9. [1d] associating the plurality of second images with second movement states of the mobile object using the first [sic] measurements; and

[219] In my opinion, Weese discloses "associating the plurality of second images with second movement states of the mobile object using the first [sic] measurements," as recited in [1d]. Here, I use "[sic]" to point out that the claim requires using the ***first*** measurements, not the second measurements, when

associating second images with second movement states. [1] As I will show, Weese discloses and renders obvious [1d] ***thirteen*** different ways.

[220] Weese repeatedly describes tracking changes to the "state of motion" of an object with a "state of motion function" that contributes to a "**motion model**" based on **I2** and **I3** and using this model to register PET and CT images, which discloses [1d]. *See, e.g.*, Weese, Abstract, ¶¶ [0005]-[0007], [0010], [0012]-[0017], [0020]-[0025], [0031], [0033], [0057], [0062]-[0071], [0083], Figs. 1-3, 5, claims 1, 5. I will explain in ***three*** steps that Weese's "state of motion function" and "**motion model M2**" disclose and renders obvious [1d], "associating the plurality of second images with second movement states of the mobile object using the first measurement." At a high level, these three steps are:

- ***First***, I will show that Weese's "state of motion function" and the "**motion model**" both describe "second movement states of the mobile object," as recited in [1d]. § XII.B.9.a (below).

[1] To the extent Patent Owner argues "first" is a typographical error and the claim should recite "second," my analysis of limitation [12d] demonstrates that Weese discloses "associating the plurality of second images with second movement states of the mobile object using the second measurements." § XII.M.9 ([12d]).

- ***Second***, I will show Weese discloses "associating the plurality of second images with second movement states of the mobile object," as recited in [1d], ***thirteen different ways*** because the **motion model** is used for various image processing steps involving the second images **I0** (or **I10**) in Weese's embodiments. § XII.B.9.b (below). It does so in relation to Figures 1-2, the modified figure I provided, and Figure 3.
- ***Third***, I will show Weese discloses "associating the plurality of second images with second movement states of the mobile object, ***using the first measurements***," as recited in [1d], by associating the "state of motion function F1" and the "motion model M2" with images **I2** and **I3**, which are based on "first measurements." § XII.B.9.b (below).

[221] Below, for the embodiments of Figures 1, 2, the modified figure I provided, and Figure 3, I added the annotation "**[1d]**" to illustrate how it relates to Weese's embodiments per the following discussion.

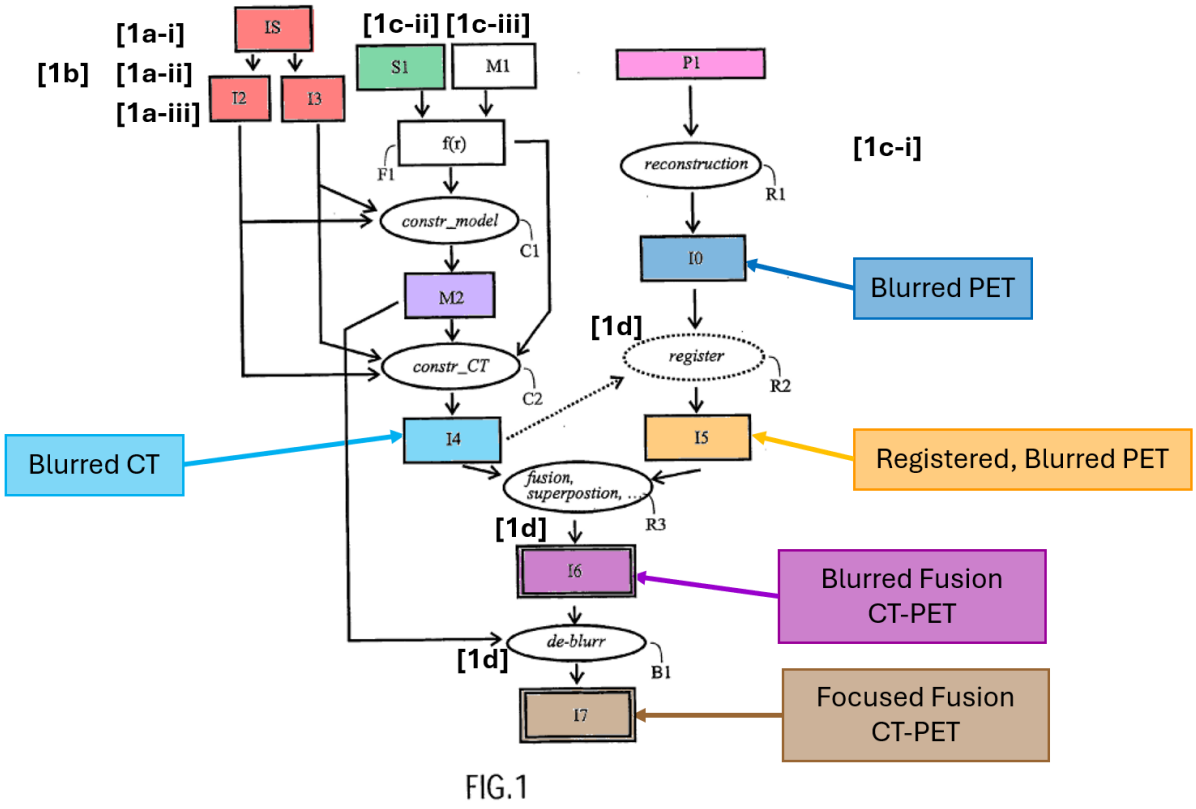


FIG.1

Weese, Fig. 1 (annotated)

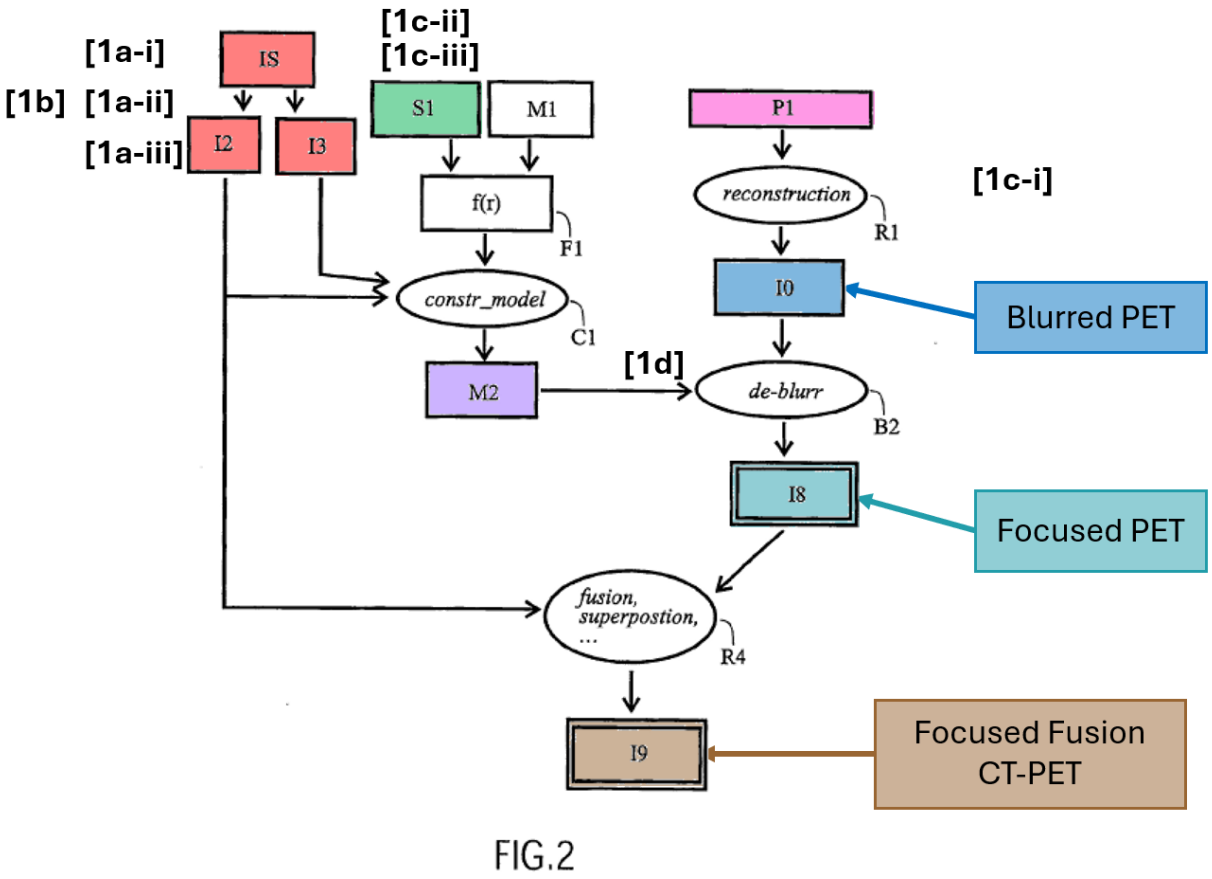
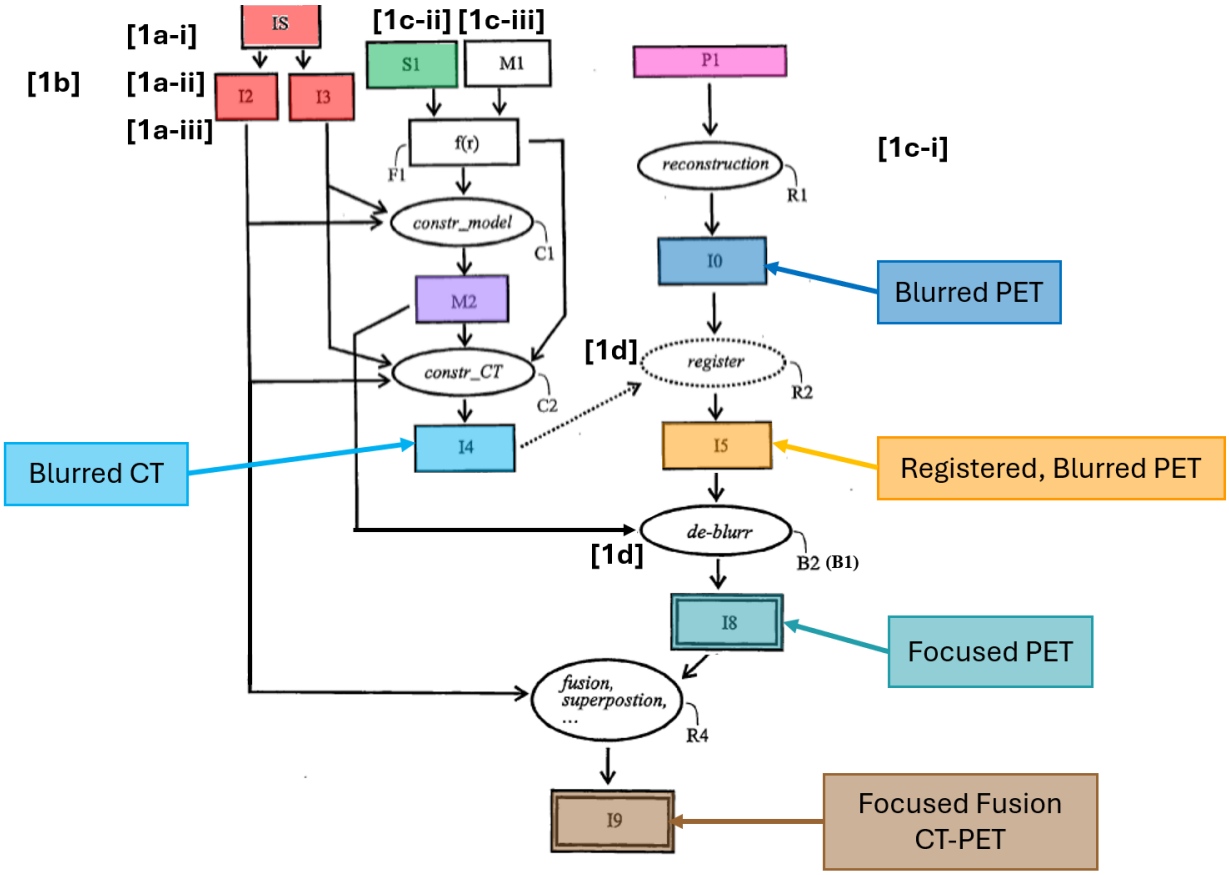


FIG.2

Weese, Fig. 2 (annotated)



Weese, modified Figs. 1-2 (annotated)

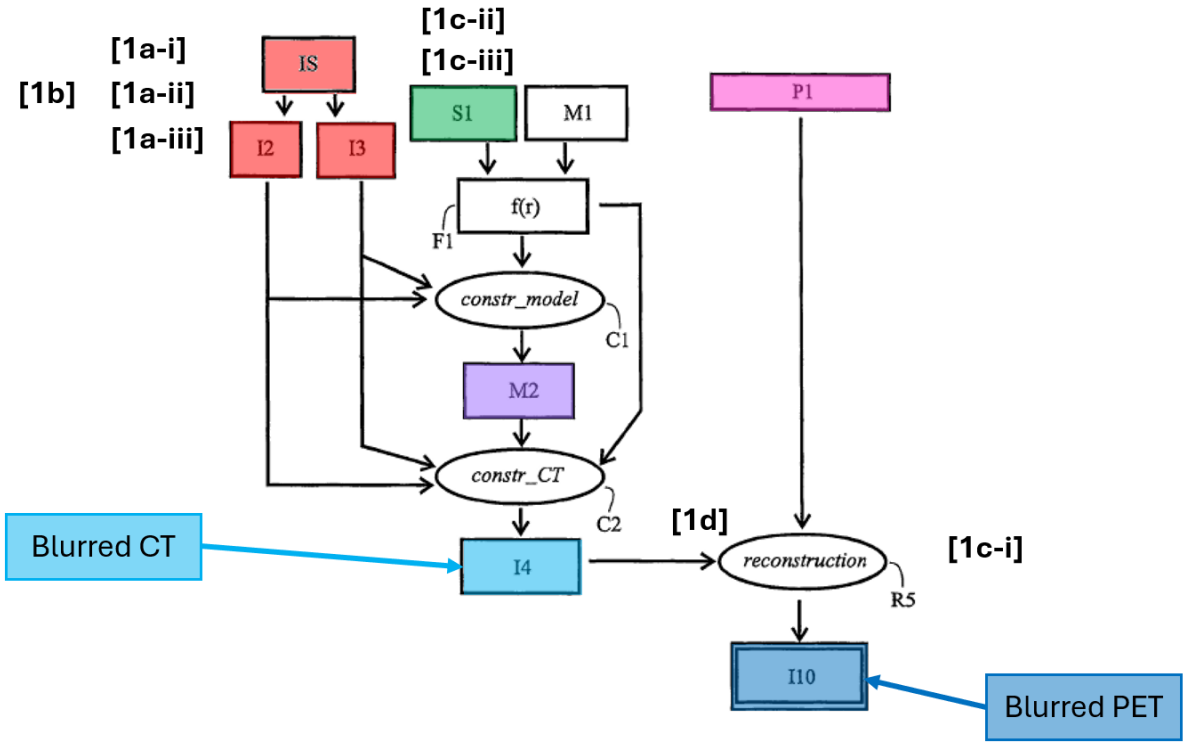


FIG.3

Weese, Fig. 3 (annotated)

a. Weese discloses "second movement states of the mobile object"

[222] Beginning with the ***first*** point, above, Weese's "state of motion function" and the "motion model" both describe "second movement states of the mobile object," as recited in [1d]. *See* §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). For example, Weese's "state of motion function" may be "a frequency function $f(r)$ for the human respiratory motion." Weese, ¶ [0063], Figs. 4-5 (shown below). Weese's Figures 4-5 show example state of motion functions, $f(r)$, for motion states r. Weese, ¶¶ [0043]-

[0044], [0063], [0067]. The state r may describe, for example, diaphragm position. Weese, Fig. 4. More generally, the state of motion function F1 "describes the overall motion process (states of motion as well as their frequency and completion in time)." Weese, ¶ [0064]. Weese's "state of motion function F1" thus discloses "second movement states of the mobile object," as recited in [1d].

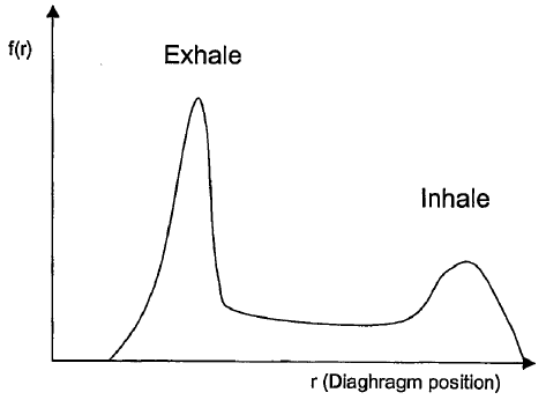


FIG.4

Weese, Fig. 4

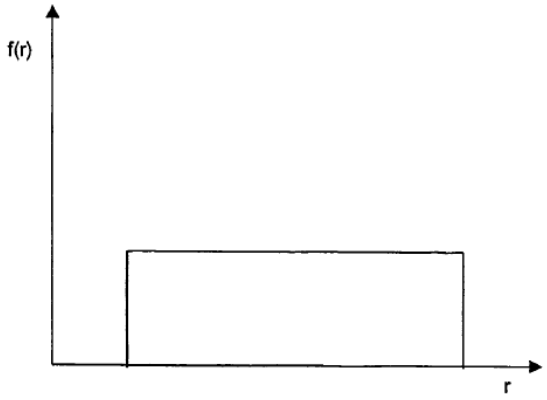


FIG.5

Weese, Fig. 5

[223] Weese's **motion model M2** also discloses "second movement states of the mobile object," as recited in [1d]. The **motion model** mathematically describes the position and motion of objects during "complex natural motion." Weese, ¶¶ [0012], [0063]-[0069]. The **motion model** represents movement states that include, for example, full inhale and exhale or any other state in a breathing cycle or other motion. Weese, ¶¶ [0012], [0062], [0066]-[0067], Figs. 4-5. Weese elaborates that "the motion model describes the behavior for different parts of the object during the motion from one state of motion to the other," i.e. its motion model comprises "second movement states of the mobile object," as recited in [1d]. Weese, ¶ [0012].

[224] Weese presents a vector field as an exemplary **motion model**. Weese states a "location-specific motion process can be retained in a vector field [that] constitutes, in conjunction with the state of motion function F1, the **motion model M2**." Weese, ¶ [0066]. These motion vectors "indicate[] the direction in which and the speed at which or the distance over which a pixel or an object component moves during the execution of the motion between each time two states of motion." Weese, ¶ [0066]. The motion vectors accordingly characterize "second movement states of the mobile object," as recited in [1d]. *E.g.*, Weese, ¶¶ [0066]-[0067].

[225] For example, in the **motion model**, vector $\overrightarrow{x_2}$ represents "the inhaled state" and $\overrightarrow{x_3}$ represents "the exhaled state." Weese, ¶ [0067]. Weese further expresses a formula for "each state of motion" as $\vec{x}(r) = \overrightarrow{x_3} + r\vec{m}(\overrightarrow{x_3})$. *Id.* Here,

parameter r varies between 0 and 1 and represents a state of a breathing cycle. *Id.* The "motion vector field" $\vec{m}(\overrightarrow{x_3})$ describes the motion of the object, and the function $\vec{x}(r)$ gives object position. Weese, ¶ [0067]. Weese's **motion model** thus plainly discloses "second movement states of the mobile object," as recited in [1d].

b. Weese discloses "associating the plurality of second images with second movement states of the mobile object"

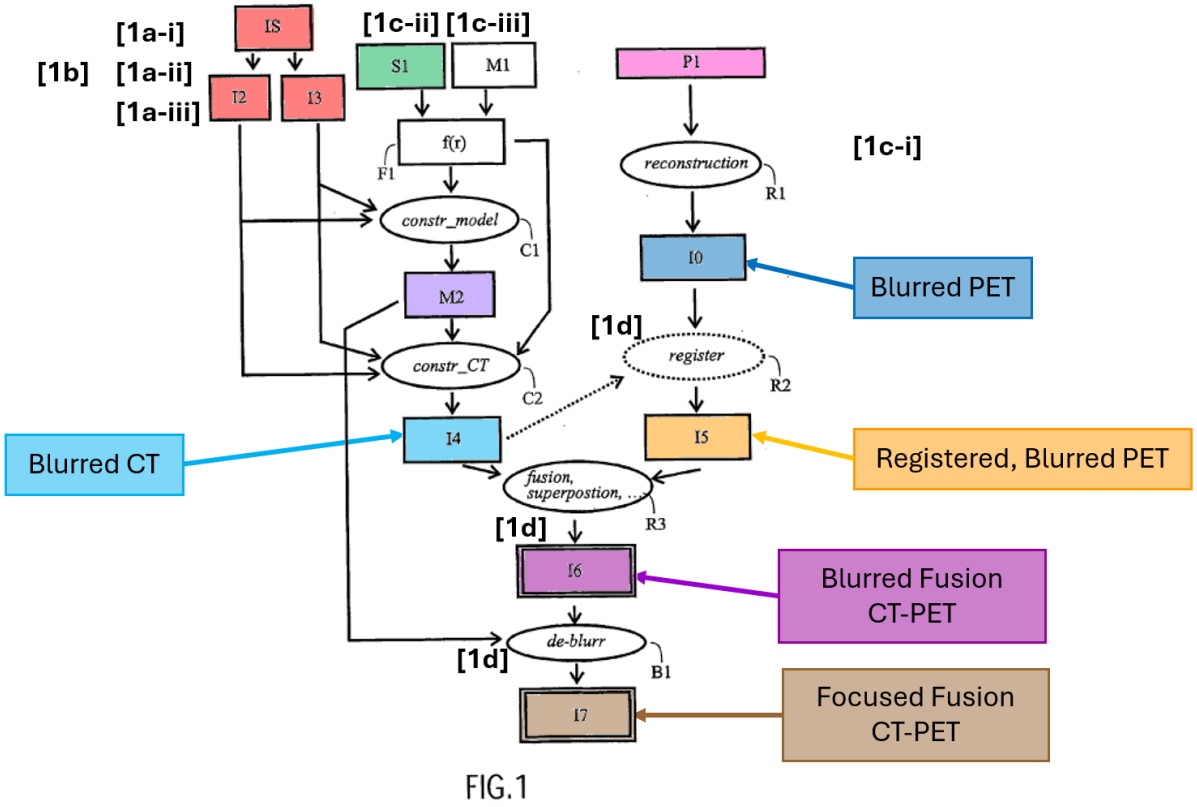
[226] Next, I will address the ***second*** point, above: Weese discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object," as recited in [1d]. It does so in relation to Figures 1, 2, the modified figure I provided, and Figure 3.

[227] The methods I will describe below for embodiments of Figures 1-3 and the modified figure associate image **I0** with F1 and **M2** in ***thirteen*** different ways—three for Figure 1, two for Figure 2, three for the modified figure, and five for Figure 3. Each such association is consistent with descriptions in the '353 patent regarding "associating the plurality of second images with second movement states of the mobile object." In one example from the '353 patent, "attenuation and emission measurements made in steps Et1 and Et2 [of] Fig. 1" are simply "associated" with phases of a breathing cycle in a plot. Ex-1001, 2:53-3:2; Fig. 2 (plotting attenuation or emission measurements M1 to M6 alongside "average" phases φ_1 to φ_6). Similarly, as I will explain, Weese discloses associating PET

images **I0** (or **I10**) to phases of a breathing cycle using F1 and **M2** in multiple ways. *E.g.*, Weese, ¶¶ [0067]-[0070], [0083], Figs. 1-3.

i. Figure 1 renders "associating the plurality of second images with second movement states of the mobile object" obvious in three ways

[228] Figure 1 discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object" in three ways, which I illustrate by annotating with "**[1d]**" in three places:



Weese, Fig. 1 (annotated)

[229] First, Weese's description of Figure 1 discloses and renders obvious [1d] by creating **registered, blurred CT image I5** when Weese's PET and CT

systems are separate and not co-located. Weese employs **motion model M2** to create **blurred CT image I4** for registering **I0** to create **I5**. Weese, ¶¶ [0069] (creating **I4** using **M2**), [0072]-[0075] (registering **I5** to coordinate system of **I4**). Weese discloses "**I4** represents a superposition of all states of motion weighted by the relevant duration of stay" because it is the integral of **M2** over all states of motion. Weese, ¶ [0069]. Logically, this associates the motion states of **M2** with **I0** because:

- **I5** associates **I0** and **I4**; and
- **I4** is based on the motion states of **M2**;
- so the process of forming **I5** associates **I0** with the motion states of **M2**.

Weese, ¶¶ [0069], [0072]-[0075].

[230] Next, Weese discloses this limitation for Figure 1 another way when Weese's PET and CT systems are separate and not co-located by generating **blurred fusion CT-PET image I6**. **M2** creates blurred CT image **I4** to fuse with registered, blurred PET image **I5** and generate **I6**. Weese, ¶¶ [0069] (creating **I4** using **M2**), [0075]-[0076] (combining **I4** and **I5** to generate **I6**), Fig. 1. Logically, this process associates the motion states of **M2** with **I0** because:

- **I6** associates **I5** and **I4**;
- **I5** is based on **I0** and **I4**; and
- **I4** is based on the motion states of **M2**;

- so, the process of forming **I6** associates **I0** with the motion states of **M2**.

Weese, ¶¶ [0069], [0075]-[0076], Fig. 1.

[231] Weese discloses this limitation for Figure 1 yet another way by using **M2** to deblur **I6** and create **focused, fusion CT-PET image I7**. Weese, ¶¶ [0077] (describing step B1 to focus **I6** and create **I7**), [0080] (focusing B1 "by means of motion model M2"), Fig. 1 (M2 as input to focusing B1). In embodiments when Weese's PET and CT systems are separate and not co-located, this logically associates the motion states of **M2** with **I0** because:

- **I7** associates the motion states of **M2** and **I6**;
- **I6** is based on **I5**; and
- **I5** is based on **I0**;
- so the process of forming **I7** associates **I0** with the motion states of **M2**.

Weese, ¶¶ [0077], [0080], Fig. 1.

[232] For combined PET and CT systems, the registration step to form **I5** is skipped, and **I6** is based on **I0**. Weese, ¶¶ [0072]-[0076]. This also logically associates the motion states of **M2** with **I0** because:

- **I7** is based on the motion states of **M2** and **I6**;
- **I6** is based on **I0**;
- so the process of forming **I7** associates **I0** with the motion states of **M2**.

Weese, ¶¶ [0072]-[0076], Fig. 1.

[233] Weese thus discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object" in three ways in relation to Figure 1.

ii. Figure 2 renders "associating the plurality of second images with second movement states of the mobile object" obvious in two ways

[234] Figure 2 discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object" in two ways, which I illustrate by annotating Figure 2 with "**[1d]**" in two places:

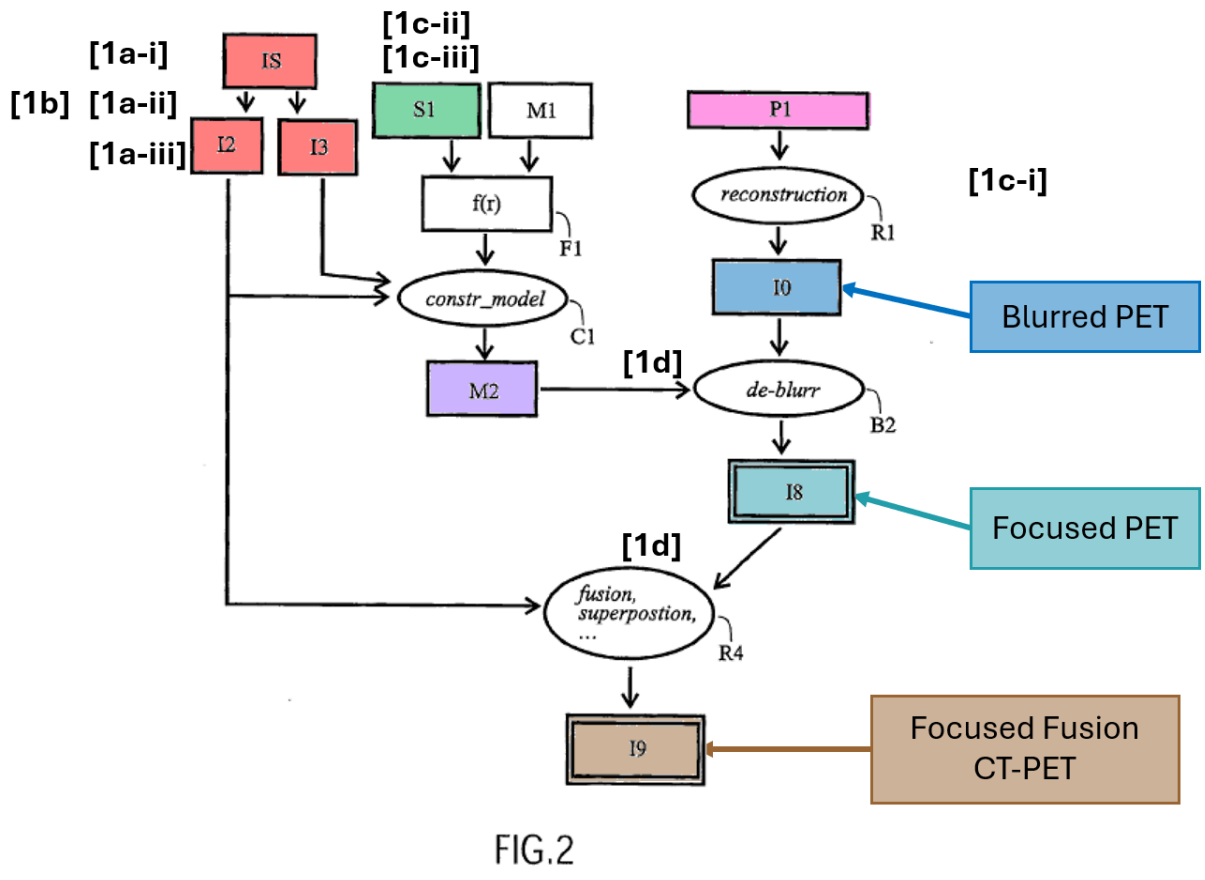


FIG.2

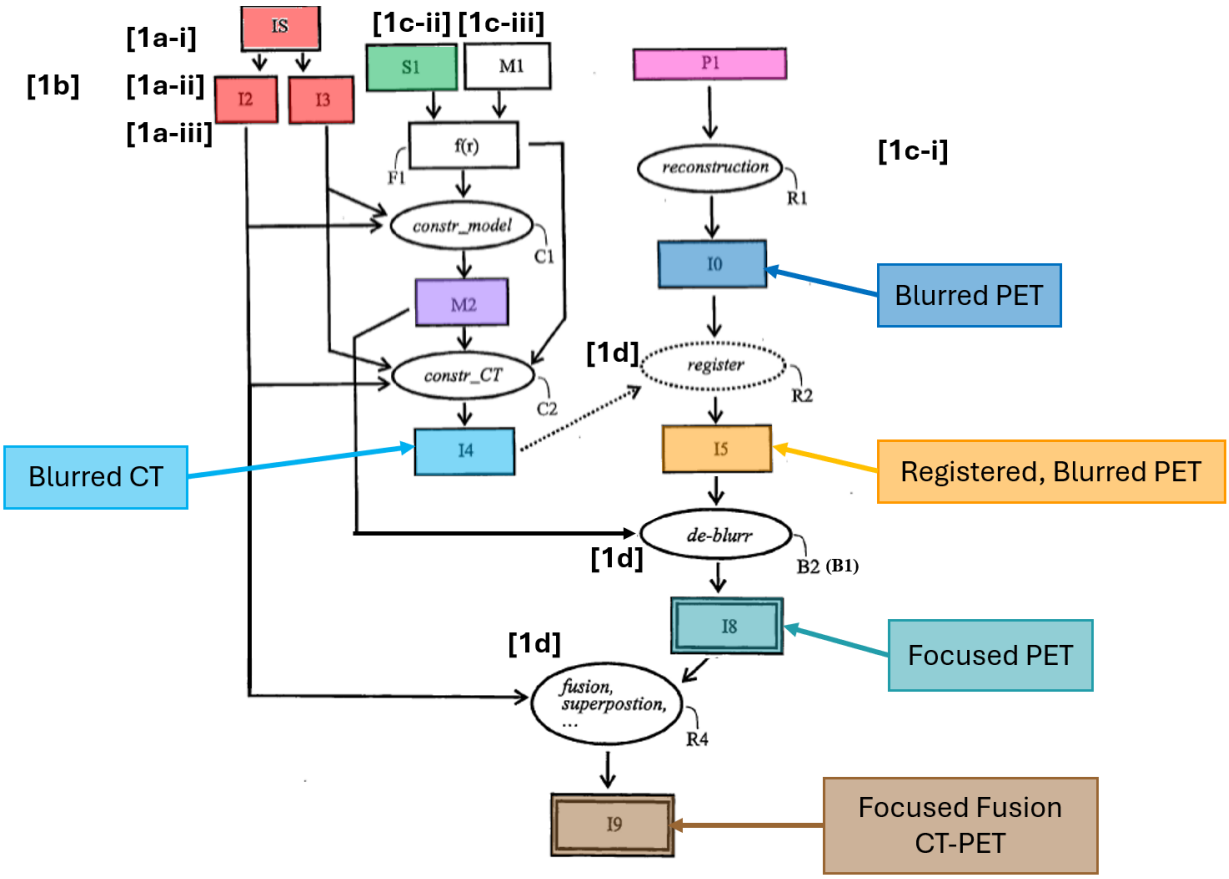
Weese, Fig. 2 (annotated)

[235] First, as shown, Weese's **M2** de-blurs **I0** to create **focused PET image I8**, thereby associating the movement states of **M2** with **I0**. Weese, ¶¶ [0078]-[0080], Fig. 2. This applies to Weese's combination PET-CT apparatus. Weese, ¶¶ [0078]-[0080]. Weese discloses the focusing "is carried out in such a manner that the sharper PET image **I8** represents the same state of motion as acquired CT image, in this case **I2**." Weese, ¶ [0079]; *see* Weese, ¶¶ [0063]-[0069] (describing construction of **M2**). That is, **I8** represents a motion state of **M2**.

[236] Second, by extension, creating **I9** also associates the movement states of **M2** with **I0** because **I9** is based on **I8**. Weese, ¶¶ [0078]-[0080], Fig. 2.

iii. The modified figure renders obvious "associating the plurality of second images with second movement states of the mobile object" in three ways

[237] The modified figure that I introduced also discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object" in three ways, which I illustrate by adding "**[1d]**" in three places to the modified figure:



Weese, modified Figs. 1-2 (annotated)

[238] As shown, Weese's **motion model M2** creates **blurred CT image I4** for registering **I0** to create **registered, blurred CT image I5**, the same process as for Figure 1. Weese, ¶ [0080], Figs. 1-2; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). As I explained above for Figure 1, this logically associates the motion states of **M2** with **I0** because:

- **I5** is based on **I0** and **I4**; and
- **I4** is based on **M2**;
- so **I5** is based on **I0** and the motion states of **M2**.

Weese, ¶ [0080], Fig. 2.

[239] In addition, the modified figure shows that M2 de-blurs I5 to create **focused PET image I8**. §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). Forming I8 associates the motion states of M2 with I5, which is based on I0, and therefore logically associates the motion states of M2 with I0.

[240] Likewise, the modified figure forms focused-fusion PET-CT image I9 from I8 and I2. §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). By extension, this also logically associates the motion states of M2 with I0 for the same reasons forming I8 associates M2 and I0.

iv. Figure 3 renders [1d] obvious in five ways

[241] Figure 3 discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object" in five ways. I illustrate one of them by adding "**[1d]**" to Figure 3, but the others are disclosed via the combination of Figure 3 with Figures 1 and 2 for embodiments with a combination PET-CT system. *See* Weese, ¶ [0084] (combining Fig. 3 with Figs. 1-2 "at will.").

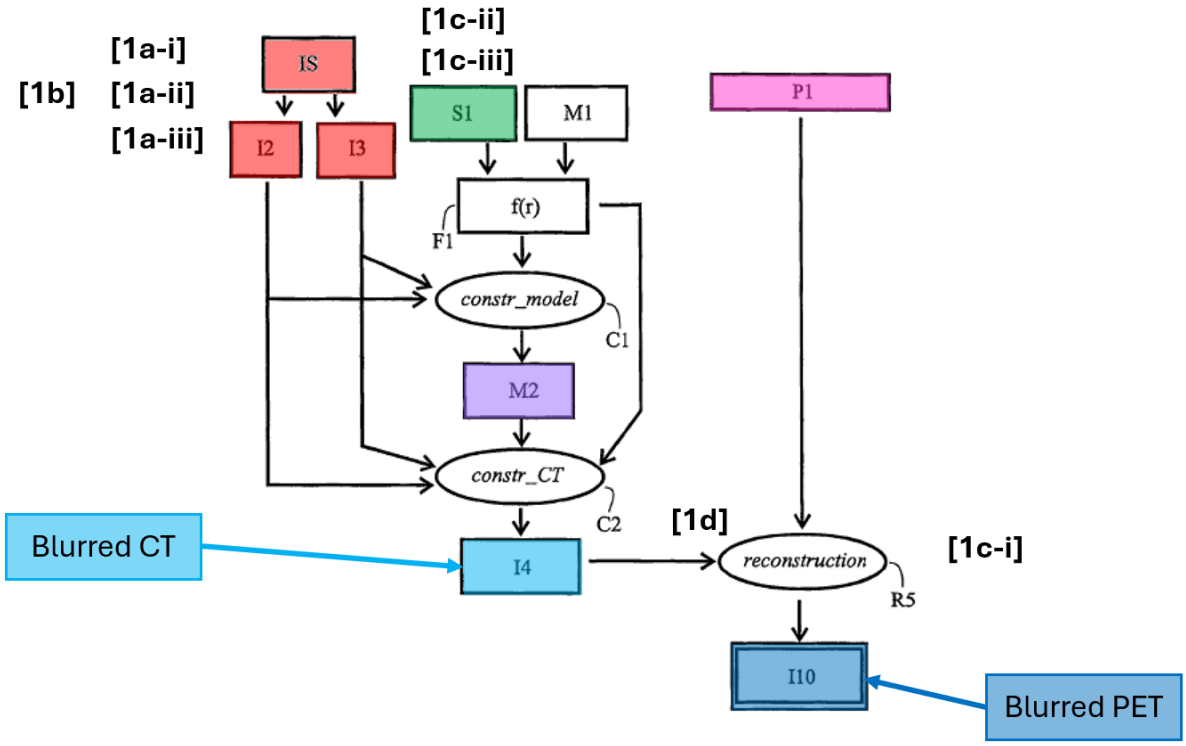


FIG.3

Weese, Fig. 3 (annotated)

[242] As shown, Figure 3 uses M2 to form blurred CT image I4, and it uses I4 to reconstruct projections P1 and create PET image I10, thereby associating the movement states of M2 with I10. Weese, ¶¶ [0078]-[0080], Fig. 3. Weese explains this approach accounts for attenuation due to motion artifacts caused by the movement states captured in M2, describing I10 as "enhanced" when compared to I0 because of I10's association with motion states in M2. Weese, ¶¶ [0081]-[0083]. For example, paragraphs [0082]-[0083] explain the approach of Figure 3 using motion model M2 eliminates "cause 2" motion artifacts described in paragraph [0051]. Figure 3 thus discloses one way to "associate[e] the plurality of second

images with second movement states of the mobile object" by reconstructing **I10** based on **M2**.

[243] Then, because Weese explains Figure 3's method "can be combined at will" with the methods of Figures 1-2, **I10** plays the role of **I0** in Figures 1 and 2 when using a combination PET-CT apparatus. Weese, ¶ [0084]. In those embodiments, each of the two ways that Figure 1 and two ways that Figure 2 discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object" apply to Figure 3. §§XII.B.9.b.i (process of creating **I6** and **I7** when no registration is performed) XII.B.9.b.ii (process of creating **I8** and **I9**). In this way, Figure 3 discloses and renders obvious this limitation in four additional ways.

c. Weese discloses "associating the plurality of second images with second movement states of the mobile object *using the first measurements*"

[244] Weese discloses "associating the plurality of second images with second movement states of the mobile object *using the first measurements*," as recited in [1d]. I have already explained that Weese discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object" in multiple ways based on **motion model M2**. §§ XII.B.9.a-b. Weese does so "*using the first measurements*" because "**M2** is derived from the images **I2** and **I3** and the state of motion function F1," and images **I2** and **I3** are, in

turn, based on first measurements from **motion sensor 15**. Weese, ¶¶ [0062], [0057], [0066], Figs. 1-2, 6; *see* §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese), XII.B.3 ([1a-ii]). As an example, Weese builds motion vectors of **M2** by using the state of motion function F1 to describe the motion of objects pictured in **I2** and **I3** along a path. Weese, ¶¶ [0066]-[0067].

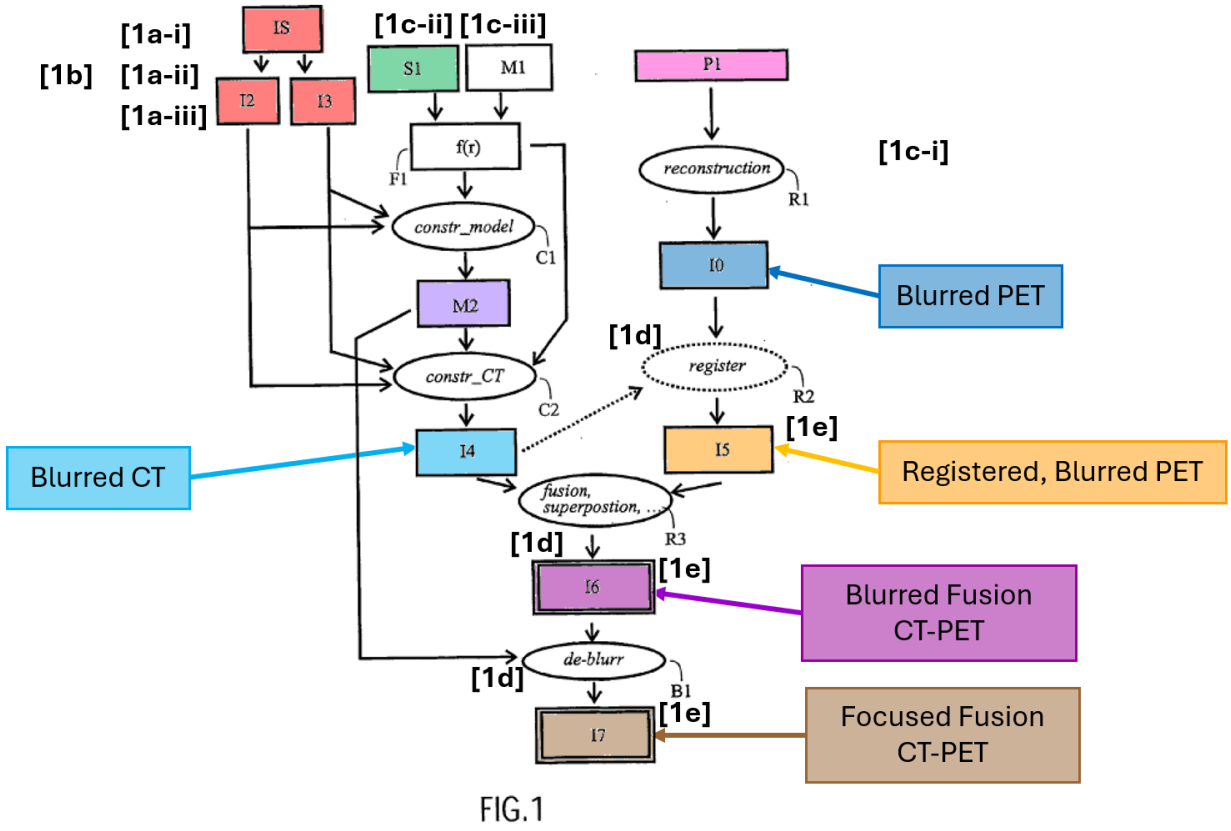
[245] Thus, "associating a plurality of second images with second movement states of the mobile object" based on **M2** "***use[es] the first measurements***," as recited in [1d], because both F1 and **M2** describe motion states (e.g., breathing states) associated with images **I2** and **I3**, which are based on measurements from **motion sensor 15**. Weese, ¶¶ [0066]-[0068]; § XII.B.3 ([1a-ii]).

10. [1e] forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states,

[246] In my opinion, Weese discloses and renders obvious "forming an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement states," as recited in [1e]. Weese does so in ***thirteen*** different ways—three for Figure 1, two for Figure 2, and three for the modified figure I provided, and five for Figure 3.

i. Figure 1 discloses and renders obvious [1e] in three ways

[247] Figure 1 discloses and renders obvious [1e] in three ways, which I have illustrated by adding "**[1e]**" to Figure 1 in three places.



Weese, Fig. 1 (annotated)

[248] As shown in Figure 1, **I5**, **I6**, and **I7** are three "image[s] of the mobile object" that are each formed based on:

- **IS**, **I2**, and **I3**, a "plurality of first images" (§ XII.B.2 ([1a-i]) corresponding to "first movement states" (§ XII.B.3 ([1a-ii])));

- measurements from **motion sensor 15**, which are "first measurements" corresponding to "first movement states" (§ XII.B.3 (1a-ii]));
- **I0**, a "plurality of second images" (§ XII.B.6 ([1c-i]));
- motion function F1, which describes "second movement states" based on "second measurements" from sensor **S1**; (§ XII.B.7 ([1c-ii]));
- **motion model M2**, which describes "second movement states" and is based on "first movement states" of **I2** and **I3**, "first measurements" from **motion sensor 15**, and "second measurements" from sensor **S1**; (§ XII.B.7 ([1c-ii])); and
- **I4**, which is based on **M2** (Weese, ¶ [0069]; § XII.B.7 ([1c-ii])).

See Weese, ¶¶ [0047]-[0077], Fig. 1. In Weese, registration and thus **I5** is needed only in embodiments with separate PET and CT systems. Weese, ¶¶ [0072]-[0075]. But the bullet points above apply to both combination PET-CT embodiments and non-combination embodiments.

ii. Figure 2 discloses and renders obvious [1e] in two ways

[249] In addition, Figure 2 discloses and renders obvious [1e] in two ways for a combination PET-CT system, which I illustrate by adding "**[1e]**" in two places to Figure 2:

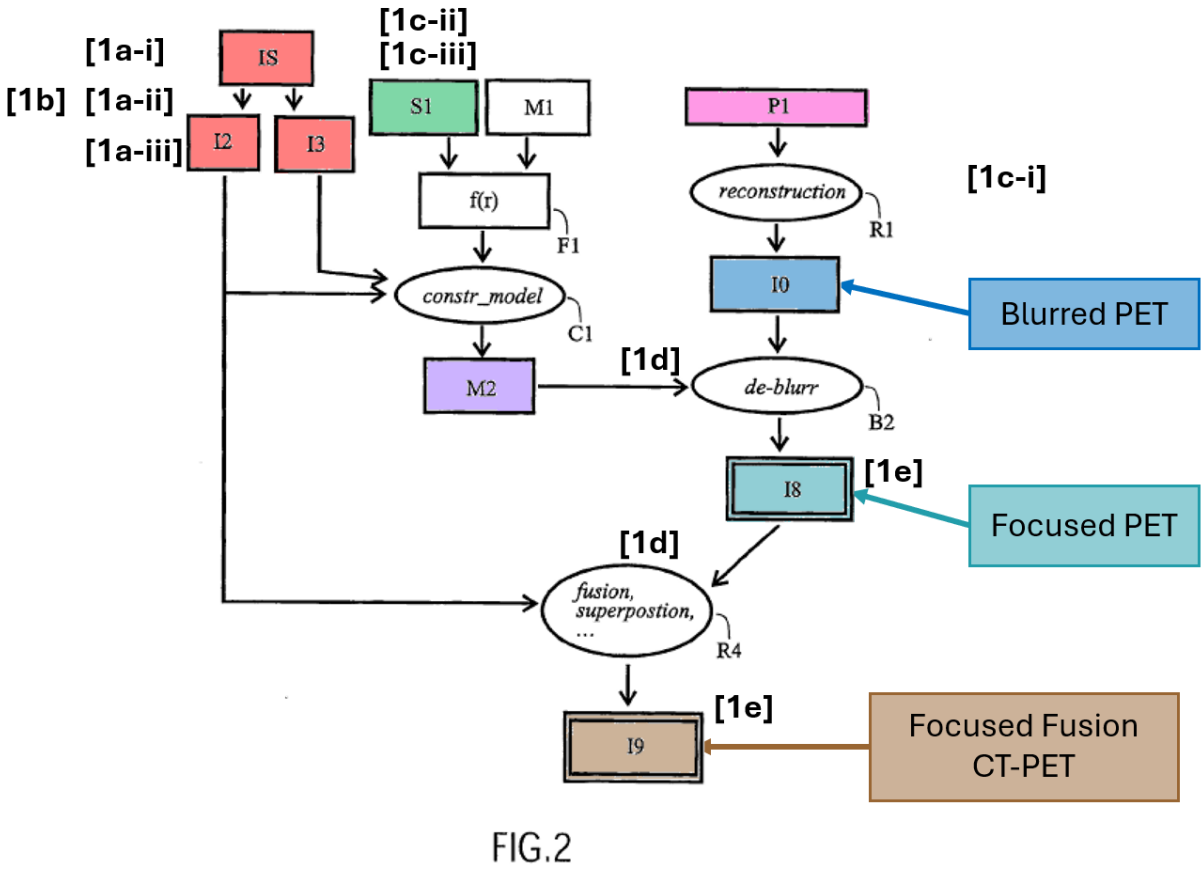


FIG.2

Weese, Fig. 2 (annotated)

[250] As shown, **I8** and **I9** are two "image[s] of the mobile object" that are each formed based on:

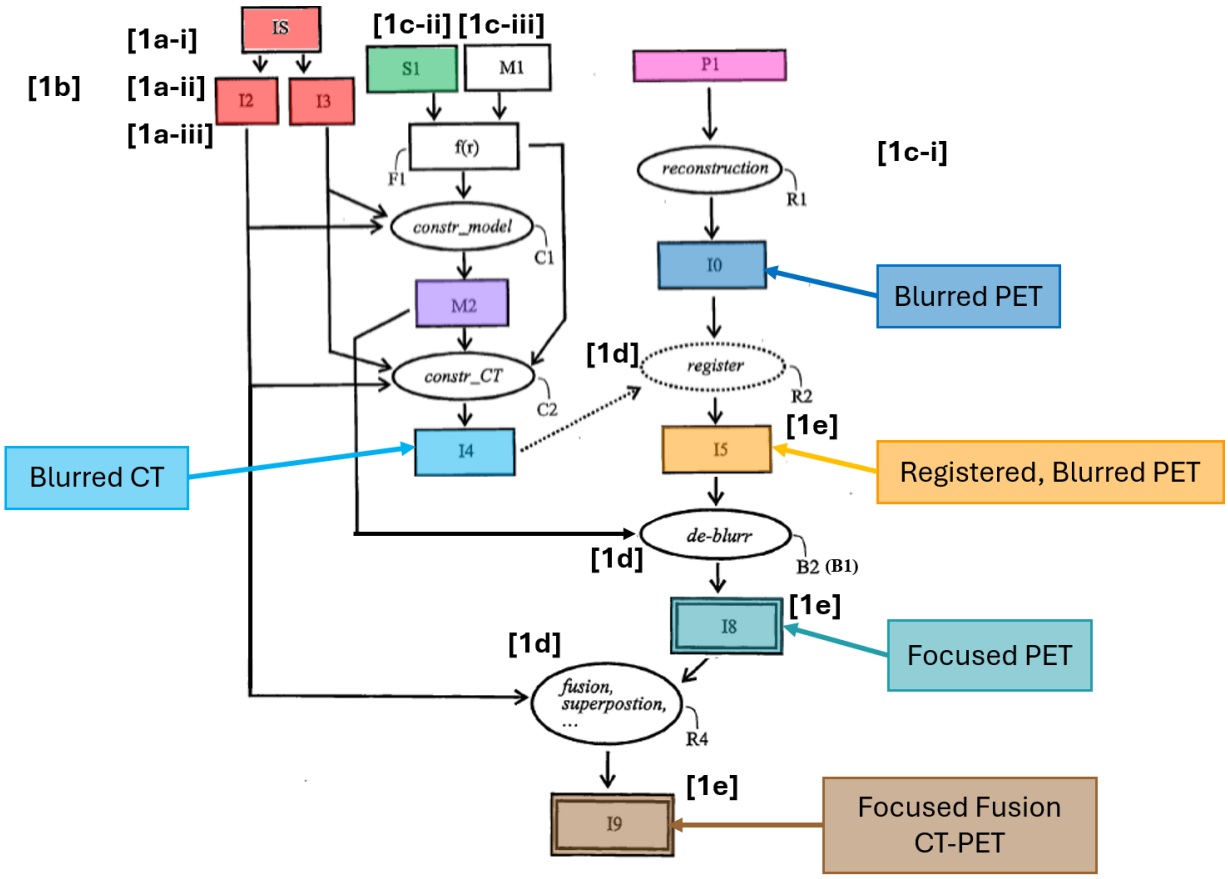
- **IS**, **I2**, and **I3**, a "plurality of first images" (§ XII.B.2 ([1a-i]) corresponding to "first movement states" (§ XII.B.3 ([1a-ii])) based on measurements from **motion sensor 15**, which are "first measurements" (§ XII.B.3 (1a-ii]));
- **I0**, a "plurality of second images" (§ XII.B.6 ([1c-i]));

- motion function F1, which describes "second movement states" based on second measurements" from sensor **S1**; (§ XII.B.7 ([1c-ii])); and
- **motion model M2**, which also describes "second movement states" and is based on "first movement states" of **I2** and **I3**, "first measurements" from **motion sensor 15**, and "second measurements" from sensor **S1**; (§ XII.B.7 ([1c-ii])).

See Weese, ¶¶ [0078]-[0080], Fig. 2; *see also* Weese, ¶¶ [0047]-[0077], Fig. 1.

iii. The modified Figure discloses and renders obvious [1e] in three ways

[251] Finally, the modified figure I provided also discloses and renders obvious [1e] in three ways, which I illustrate by adding "**[1e]**" to the modified figure in three places:



Weese, Figs. 1-2 (modified)

[252] As shown, I5, I8 and I9 are "image[s] of the mobile object" that are each formed based on:

- IS, I2, and I3, a "plurality of first images" (§ XII.B.2 ([1a-i]) corresponding to "first movement states" (§ XII.B.3 ([1a-ii]));
- I0, a "plurality of second images" (§ XII.B.6 ([1c-i]));
- motion function F1, which describes "second movement states" based on second measurements" from sensor S1; (§ XII.B.7 ([1c-ii]));

- **motion model M2**, which also describes "second movement states" and is based on "first movement states" of **I2** and **I3**, "first measurements" from **motion sensor 15**, and "second measurements" from sensor **S1**; (§ XII.B.7 ([1c-ii])); and
- **I4**, which is based on **M2** (Weese, ¶ [0069]; § XII.B.7 ([1c-ii])).

iv. Figure 3 discloses and renders obvious [1e] five different ways

[253] Figure 3 discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object" in five ways. I illustrate one of them by adding "**[1e]**" to Figure 3, but the other four ways are disclosed via the combination of Figure 3 with Figures 1 and 2 for embodiments with a combination PET-CT system. *See* Weese, ¶ [0084] (combining Fig. 3 with Figs. 1-2 "at will.").

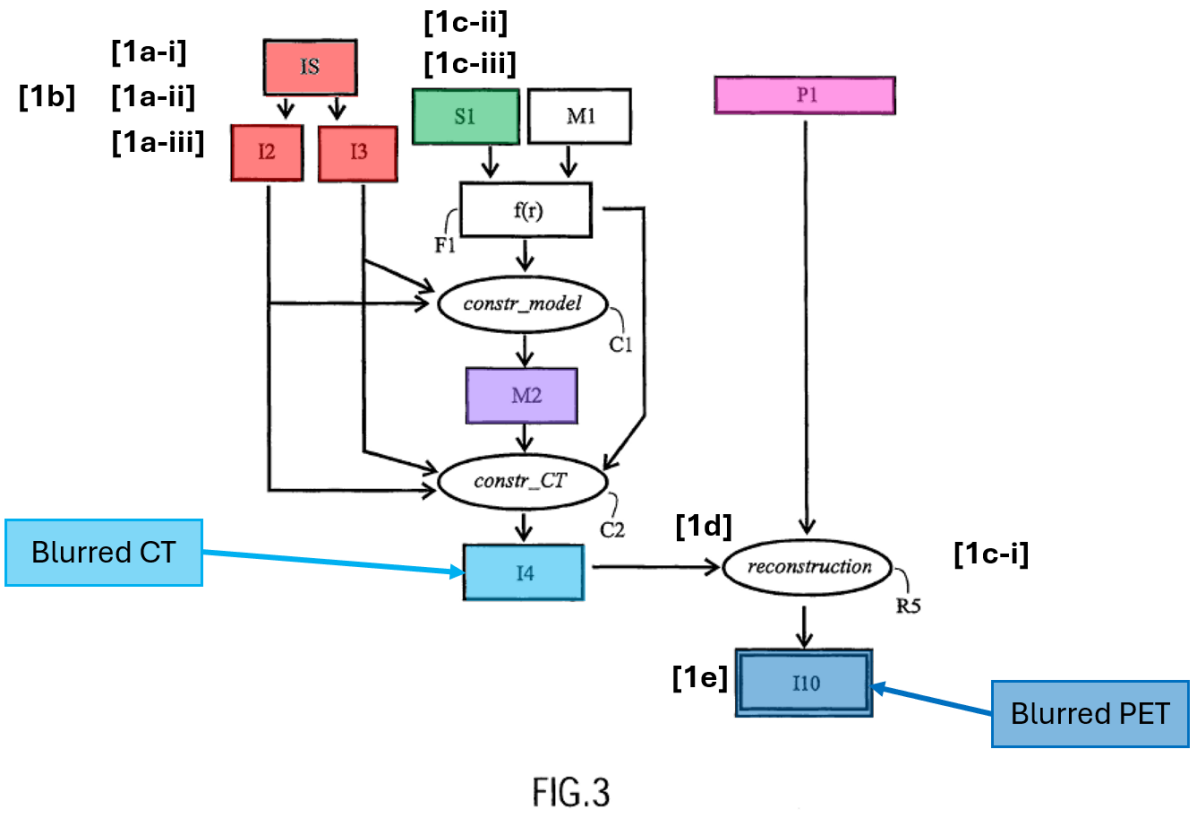


FIG.3

Weese, Fig. 3 (annotated)

[254] As shown, Figure 3 uses M2 to form blurred CT image I4, and it uses I4 to reconstruct projections P1 and create PET image I10. Weese, ¶¶ [0081]-[0084], Fig. 3. Weese explains this approach accounts for attenuation due to motion artifacts caused by the movement states captured in M2, describing I10 as "enhanced" when compared to I0 because of I10's association with motion states in M2. Weese, ¶¶ [0081]-[0083]. For example, paragraphs [0082]-[0083] explains the approach of Figure 3 using motion model M2 eliminates "cause 2" motion artifacts described in paragraph [0051]. The motion model M2 and I4 are based on a "plurality of first image" IS, I2, and I3, "first measurements" from motion

sensor 15, and "second measurements" from **sensor S1**. Weese, ¶¶ [0063]-[0070], Fig. 3; §§ XII.B.3 ([1a-ii]), XII.B.9. And as explained, **I10** is based on "plurality of second images" because it may be a volume image and because it represents a superposition of many PET images. § XII.B.6 ([1c-i]). Thus, **I10** is "an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states," as recited in [1e]. **I10** is one way Figure 3 discloses and renders obvious [1e].

[255] In addition, because Weese explains Figure 3's method "can be combined at will" with the methods of Figures 1-2, **I10** plays the role of **I0** in Figures 1 and 2 when using a combination PET-CT apparatus. Weese, ¶ [0084]. In those embodiments, each of the two ways that Figure 1 and two ways that Figure 2 discloses and renders obvious "associating the plurality of second images with second movement states of the mobile object" apply to Figure 3. §§XII.B.10.i (process of creating **I6** and **I7** when no registration is performed) XII.B.10.ii (process of creating **I8** and **I9**). In this way, Figure 3 discloses and renders obvious [1e] in four additional ways.

11. [1f] wherein the first imaging technique is different from the second imaging technique.

[256] In my opinion, Weese discloses "wherein the first imaging technique is different from the second imaging technique," as recited in [1f].

[257] In my analysis, the first imaging technique is CT imaging, while the second imaging technique is PET imaging, which are different techniques. §§ XII.B.2 (first technique, [1a-i]), XII.B.6 (second technique, [1c-i]).

C. Claim 2

[2] The method of claim 1, further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states.

[258] In my opinion, Weese discloses "[t]he method of claim 1, further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states," as recited in claim 2.

[259] As I show above, I2 and I3 are "first" images that each represent a single state of motion such as full inhale or exhale (§ XII.B.2 ([1a-i])), and I0 discloses or renders obvious "second" images (§ XII.B.6 ([1c-i])). Figure 2, the modified figure I provided, and Figure 3 each disclose the additional features of claim 2.

i. Figure 2 discloses claim 2

[260] Figure 2 discloses "time synchronizing" CT and PET images to a "common time scale" as required in claim 2 by using motion model M2 to focus I0 to the same state of motion as I2 or I3. Weese, ¶¶ [0078]-[0079], Fig. 2. Weese uses M2 so "the focusing B2 of Fig. 2 is carried out in such a manner that the sharper PET image I8 represents the same state of motion as an acquired CT image, in this case I2." Weese, ¶¶ [0071], [0078]-[0079], Fig. 2. M2 creates a common time scale based on a comparison between the "second movement states" determined by sensor S1 and the first movement states of I2 and I3. Weese, ¶¶ [0063]-[0068] (constructing M2 from I2, I3, and S1 measurements), Figs. 1-2; § XII.B.9 ([1d]). Thus, by generating I8, Figure 2 discloses claim 2.

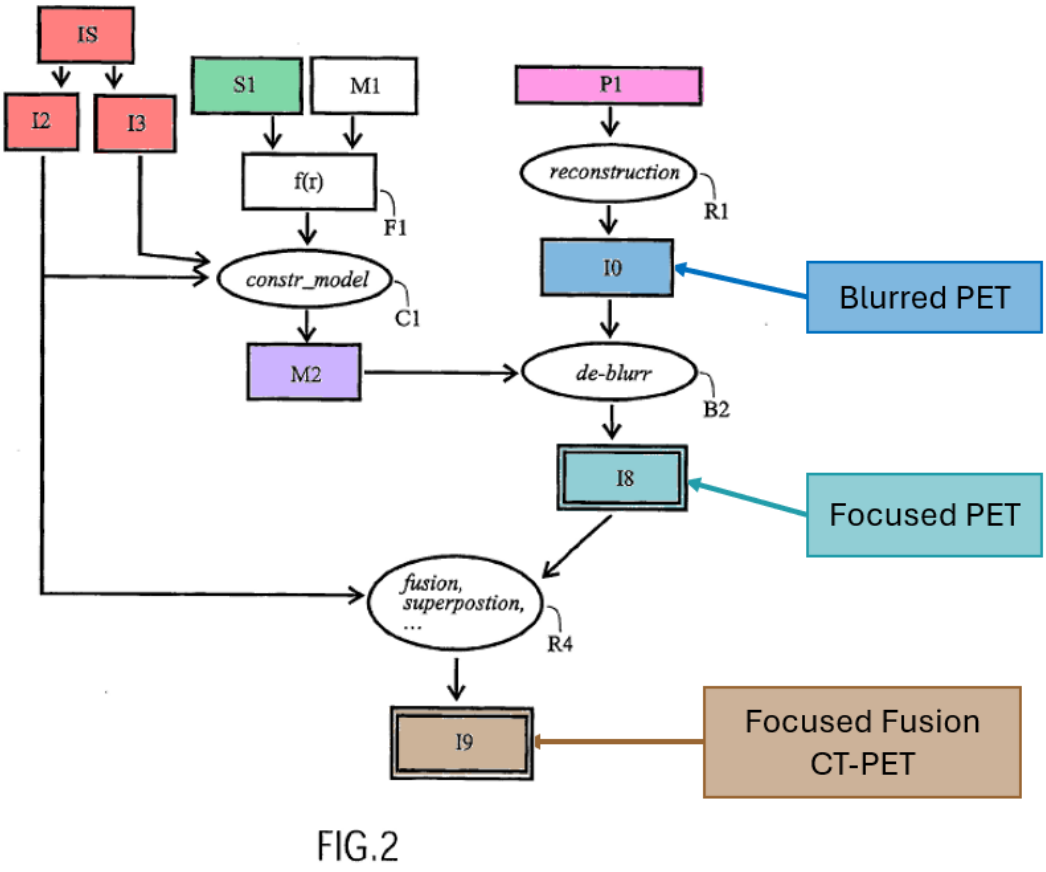


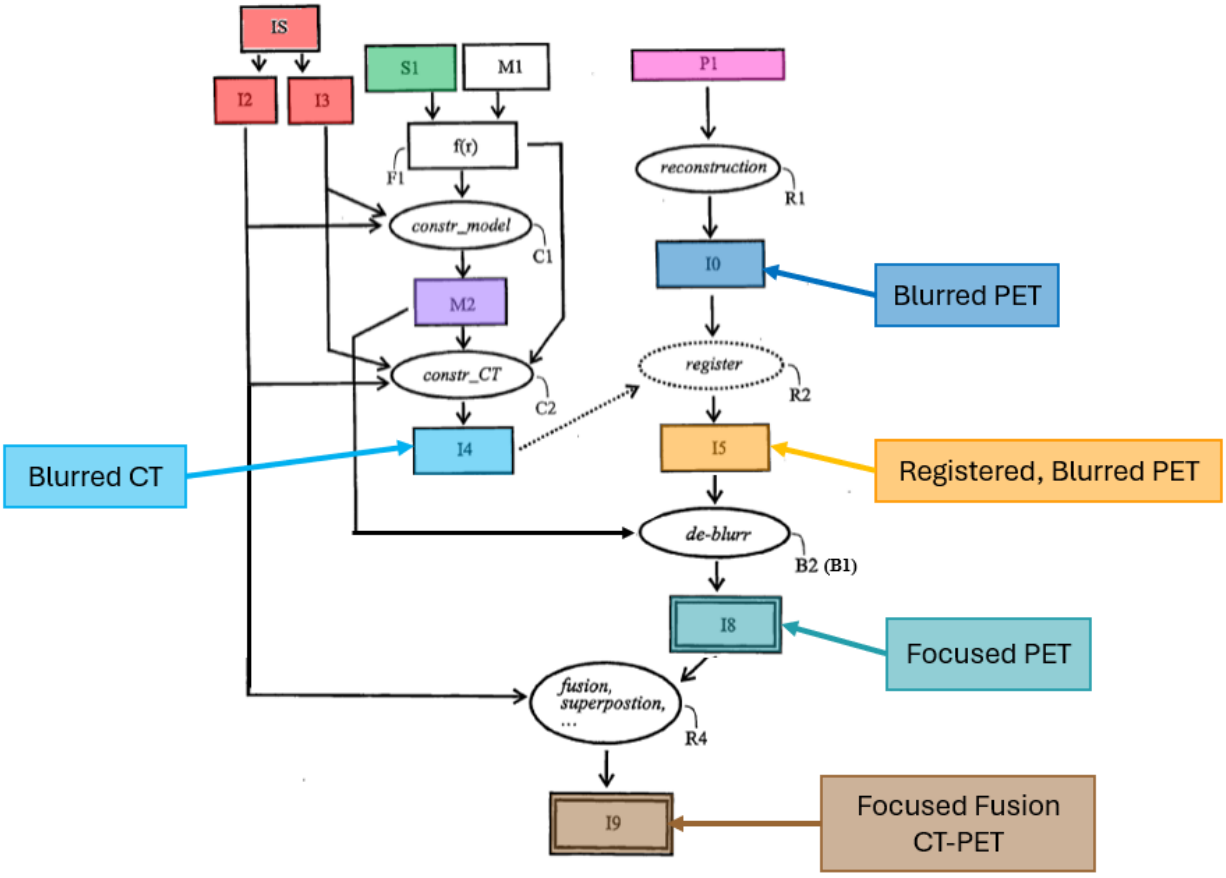
FIG.2

Weese, Fig. 2 (annotated)

ii. The modified figure discloses claim 2

[261] For similar reasons as for Figure 2, the modified figure I provided also discloses "time synchronizing" CT and PET images to a "common time scale" as required in claim 2 because it uses M2 to generate I8 from registered, blurred PET image I5. Weese, ¶ [0080] ("focusing of the image I5 by means of the motion model M2"); § XII.B.9 ([1d]). This process discloses the time synchronizing requirements of claim 2 because I8 synchronizes the blurred image of I0 to a common time scale with I2, I3, and I5 via motion model M2, which is based on the first and second

movement states. Weese ¶¶ [0063]-[0063] (constructing **M2** from **I2**, **I3**, and **S1** measurements) [0069] (generating **I4 using M2**), [0080], Figs. 1-2; § XII.B.9 ([1d]).



Weese, modified Figs. 1-2 (annotated)

iii. Figure 3 discloses claim 2

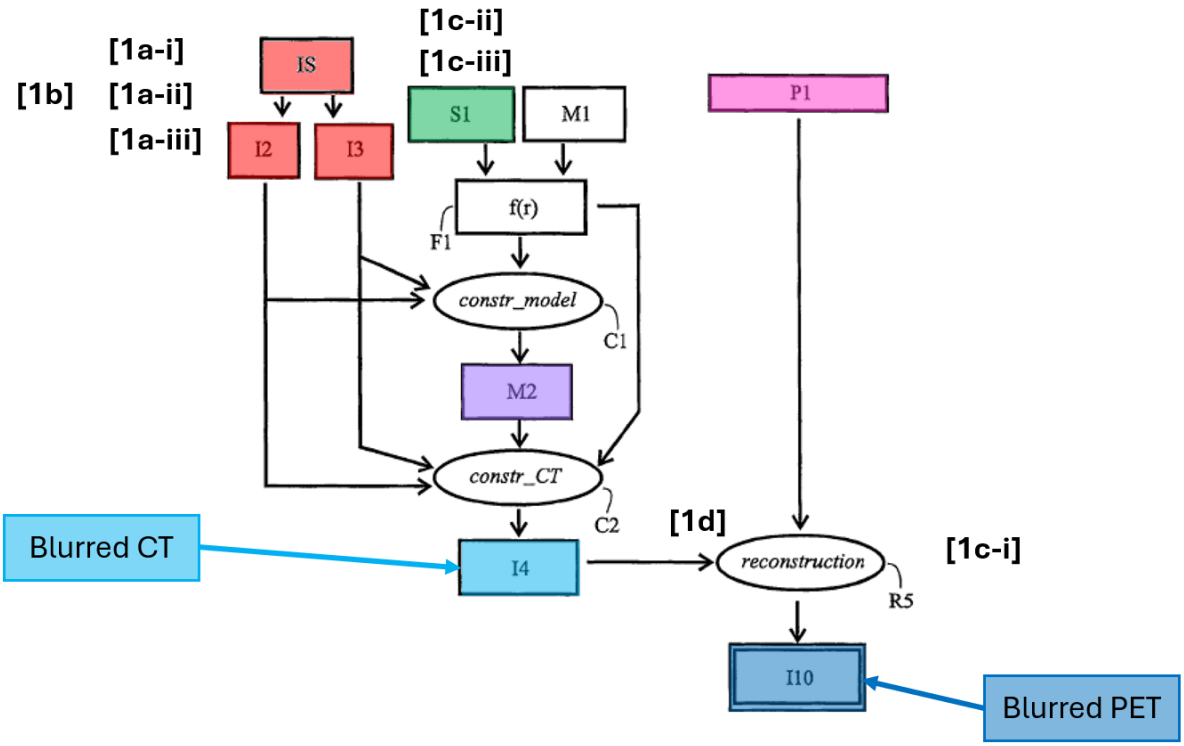


FIG.3

Weese, Fig. 3 (annotated)

[262] As shown, Figure 3 discloses "time synchroniz[ing]" CT and PET images to a "common time scale" as required in claim 2 by using **M2** to form blurred CT image **I4**, and using **I4** to reconstruct projections **P1** and create PET image **I10**. Weese, ¶¶ [0078]-[0080], Fig. 3. Weese explains this approach accounts for attenuation due to motion artifacts caused by the movement states captured in **M2**, describing **I10** as "enhanced" when compared to **I0** because of **I10**'s association with motion states in **M2**. Weese, ¶¶ [0081]-[0083]. For example, paragraphs [0082]-[0083] explain the approach of Figure 3 using motion model **M2** eliminates

"cause 2" motion artifacts described in paragraph [0051]. As explained, M2 is based on a comparison of first and second movement states and used to construct I4. Weese, ¶¶ [0063]-[0068] (generating M2 from I2, I3, and S1 measurements), [0069] (generating I4 using M2), Figs. 1-2. Figure 3 thus discloses time-synchronizing I10 with I2 and I3.

D. Claim 3

[3] The method of claim 1, further comprising: forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

[263] In my opinion, Weese discloses "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images," as recited in claim 3.

[264] For Figures 1-3 and the modified figure I provided, CT images IS, I2, and I3 are a "plurality of first images," and these images are "reconstructed" from X-ray projection data. Weese, ¶¶ [0052]-[0057], [0062], [0072], [0078]-[0079], [0084]; § XII.B.2 ([1a-i]). Weese thus discloses "forming first reconstructed images corresponding to said plurality of first images," as recited in claim 3.

[265] For Figures 1-3 and the modified figure I provided, PET images I0 and I10 disclose and render obvious a "plurality of second images," and Weese discloses I0 and I10 are "reconstructed" from projections P1. Weese, ¶¶ [0047]-[0051], [0058], [0070]-[0072], [0078]-[0079], [0084]; § XII.B.6 ([1c-i]). Weese thus

discloses "forming . . . second reconstructed images corresponding to said plurality of second images," as recited in claim 3.

E. Claim 4

[4] The method of claim 3, further comprising: spatially-synchronizing said first reconstructed images and said second reconstructed images.

[266] In my opinion, Weese discloses "[t]he method of claim 3, further comprising: spatially-synchronizing said first reconstructed images and said second reconstructed images," as recited in claim 4.

[267] As a preliminary matter, I note that the '353 patent describes "spatial synchronization" as a process that registers two images, consistent with well-known methods. Ex-1001, 3:54-61; *see* Weese, ¶¶ [0073]-[0074] (describing registration); Ex-1009 (same); Ex-1011, ¶¶ [0011], [0013]-[0014], [0033]. Indeed, the patent specifically states this process "is not innovative" and the alleged "invention is not applicable to it." Ex-1001, 3:54-61.

[268] In Weese, **IS**, **I2**, and **I3** disclose "first reconstructed images," and **I0** discloses and renders obvious "second reconstructed images." § XII.D (claim 3). Weese spatially synchronizes the first and second reconstructed images in two ways.

[269] First, for embodiments with separate, independent PET and CT systems (as in Figure 1 and the modified figure I provided), Weese discloses registering the blurred PET image **I0** to the coordinate system of **I4**, which is the coordinate system

of **IS**, **I2**, and **I3**, thereby creating **blurred, registered PET image I5**. Weese, ¶¶ [0072]-[0075], [0080], Fig. 1; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese); *see* Ex-1009 (cited in Weese, ¶ [0074]). The '353 patent discloses using a mathematical "deformation operator D" to transform coordinates from the attenuation (CT) to emission (PET) system by translation, rotation, affine, or other transformation. Ex-1001, 3:62-4:44. That is the same as Weese's approach. Weese, ¶¶ [0073]-[0074] (disclosing mathematical "coordinate transformation," including non-rigid transformation of Ex-1009); Ex-1009, 1610-11 (defining mathematical "transformation operator" through translation, rotation, and deformations). Weese's registration process therefore discloses "spatially-synchronizing said first reconstructed images and said second reconstructed images," as recited in claim 4.

[270] Weese also teaches the spatial synchronization of claim 4 by disclosing that no registration is needed to spatially synchronize **I0** and **I10** to the coordinate system of **IS**, **I2**, and **I3** when using a combination PET-CT system—they are automatically spatially synchronized. Weese, ¶¶ [0072], [0079], [0083]-[0084], Figs. 1-3. Thus, Weese discloses using a combination system to automatically "spatially-synchroniz[e] said first reconstructed images and said second reconstructed images," as recited in claim 4. Weese's synchronization in this example is consistent with the '353 patent's description of "the simplest case" of

spatial synchronization: "the patient does not move between the attenuation and emission techniques therefore in which [the deformation operator] D = identity [i.e., 1]." Ex-1001, 4:42-44.

F. Claim 5

[5] The method of claim 1, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

[271] In my opinion, Weese discloses "[t]he method of claim 1, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique," as recited in claim 5.

[272] For Figures 1-3 and the modified figure I provided, CT images **IS**, **I2**, and **I3** are a "plurality of first images," and CT is a "radiation attenuation technique." Weese, ¶¶ [0052]-[0057], [0062], [0072], [0078]-[0079], [0084]; § XII.B.2 ([1a-i]). Weese thus discloses "wherein said first imaging technique is a radiation attenuation technique," as recited in claim 5.

[273] For Figures 1-3 and the modified figure I provided, PET images **I0** and **I10** disclose and render obvious a "plurality of second images," and PET is a "radiation emission technique." Weese, ¶¶ [0047]-[0051], [0058], [0070]-[0072], [0078]-[0079], [0084]; § XII.B.6 ([1c-i]). Weese thus discloses the "second imaging technique is a radiation emission technique," as recited in claim 5.

G. Claim 6

[6] The method of claim 1, further comprising: spatially-

synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements.

[274] In my opinion, Weese discloses "[t]he method of claim 1, further comprising: spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements," as recited in claim 6.

[275] As discussed for claim 3, Figure 1 and the modified figure I provided teaches "spatially-synchronizing the plurality of first images and the plurality of second images" through its registration process in embodiments with separated and independent CT and PET systems. Weese, ¶¶ [0072]-[0075], [0080], Figs. 1, 3; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese), XII.D (claim 3).

[276] Weese's registration process involves registering **I0** to blurred, CT image I4. The motion model **M2** and **I4** are based on a "plurality of first image" **IS**, **I2**, and **I3**, "first measurements" from **motion sensor 15**, and "second measurements" from **sensor S1**. Weese, ¶¶ [0063]-[0070], Fig. 3; §§ XII.B.3 ([1a-ii]), XII.B.9. Thus, Weese's registration discloses "using said plurality of first measurements and said plurality of second measurements," as recited in claim 6.

H. Claim 7

[7] The method of claim 1, further comprising: forming displacement fields corresponding, respectively, to said plurality of

first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

[277] In my opinion, Weese discloses and renders obvious "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements," as recited in claim 7.

[278] Weese's "motion vector fields" are "displacement fields" of claim 7. As an example feature of its **motion model M2**, Weese describes forming "a motion vector field." Weese, ¶¶ [0063]-[0067]. These motion vectors are "displacement fields" as recited in claim 7, because they describe how points in an image move in conjunction with the "state of motion function F1." *Id.* Weese describes its "motion vector field" may account for non-linear "location-specific motion process" wherein different features of the image are displaced in different ways. Weese, ¶ [0067]. Weese explains the "motion vector thus indicates the direction in which and the speed at which or the distance over which an object component moves during the execution of the motion . . . ." Weese, ¶ [0067]. Weese's motion vector fields are therefore "displacement fields," as recited in claim 7.

[279] Weese's motion vector fields correspond to "first images" **I2** and **I3**. Weese, ¶¶ [0063]-[0068]. For example, Weese expresses a formula for "each state of motion" as $\vec{x}(r) = \overrightarrow{x_3} + r\vec{m}(\overrightarrow{x_3})$. Weese, ¶ [0067]. Here, parameter r varies

between 0 and 1 and represents a state of a motion in a cycle based on the state of motion function F1. *Id.* For a breathing cycle, $\vec{x}(r = 0) = \overrightarrow{x_3}$ represents "the exhaled state" corresponding to **I3**, and $\vec{x}(r = 1) = \overrightarrow{x_2}$ represents "the inhaled state" corresponding to **I2**. Weese, ¶ [0067]. The "motion vector field" $\vec{m}(\overrightarrow{x_3})$ describes the motion of the object, and the function $\vec{x}(r)$ gives object position as function of the state of motion—both are "displacement fields," as recited in claim 7. Weese, ¶ [0067]. And as previously explained, images **I2** and **I3** are the claimed "first images." § XII.B.2 ([1a-i]). Weese's motion vectors are therefore "displacement fields corresponding, respectively, to said plurality of first images" **I2** and **I3**, as recited in claim 7.

[280] In addition, Weese's motion vector fields correspond to "first measurements" from **motion sensor 15**. Weese, ¶¶ [0063]-[0068]. As I just explained, Weese's motion vector fields correspond to images **I2** and **I3**. *Supra*. And images **I2** and **I3** correspond to "first measurements" from **motion sensor 15** because they are extracted from **IS** using measurements from **motion sensor 15**. Weese, ¶¶ [0031], [0057], [0065], [0072]-[0074], [0078]-[0080]; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese), XII.B.3 ([1a-ii]). Therefore, Weese's motion vector fields are "displacement fields corresponding, respectively, to . . . said plurality of first measurements" from **motion sensor 15**, as recited in claim 7.

[281] In addition, Weese's motion vector fields correspond to "second measurements" from **motion sensor S1**. Weese uses **sensor S1** to derive the "actual motion" signal "during the acquisition of PET projections **P1**" to determine the "state of motion function" used to determine its motion vector fields $\vec{m}(\vec{x_3})$. Weese, ¶¶ [0065]-[0067]. The motion vector fields therefore correspond to measurements from **S1**. And as previously explained, measurements from **S1** are the claimed "second measurements." § XII.B.7 ([1c-ii])). Weese's motion vector fields thus are "displacement fields corresponding, respectively, to . . . said plurality of second measurements" from **sensor S1**, as recited in claim 7.

[282] Finally, Weese discloses PET image **I0** "constitutes a superposition of all states of motion weighted by the relative duration of stay." Weese, ¶ [0070]. Weese explains **I0** is:

> formed from the integral over all states of motion r of the product of an image $\mathbf{I0}_a$ (not shown in this case) of an initial state of motion, the frequency function $f(r)$ and the motion model $\left(\vec{x}_a + \vec{m}(\vec{x}_a)\right)$:
>
> $$\int_0^1 f(r) I0_a(\vec{x}_a + \overrightarrow{rm}(\vec{x}_a) dr$$

Weese, ¶ [0070]. Weese discloses the image $\mathbf{I0}_a$ represents a state of motion and in the "ideal case" it represents the same state of motion as the image **I3** and the vectors

$\vec{x}_a$ and $\vec{x}_3$." Weese, ¶ [0071]. Weese thereby discloses its motion vectors are "displacement fields corresponding, respectively, to . . . said plurality of second images" **I0**, as recited in claim 7. Weese further discloses this limitation when it teaches using the motion model **M2** to focus **I0** in the context of Figure 2 and the modified figure I provided, above. Weese, ¶¶ [0078], [0080], Fig. 2; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese).

[283] Weese's motion vector fields therefore disclose and render obvious "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements," as recited in claim 7.

I. Claim 8

[8] The method of claim 7, wherein said forming an image of the mobile object comprises combining said displacement fields.

[284] In my opinion, Weese discloses "[t]he method of claim 7, wherein said forming an image of the mobile object comprises combining said displacement fields," as recited in claim 8.

[285] Weese discloses and renders obvious "forming displacement fields" as required in claim 7. § XII.B.7. And I previously explained for limitation [1e] that Weese discloses and renders obvious "forming an image of a mobile object" by forming each of:

- **I5**, **I6**, and **I7** (Figure 1);

- I8 and I9 (Figure 2);
- I5, I8 and I9 (modified figure);
- I10 (Figure 3), I6 and I7 (combination of Figures 1 and 3 per Weese, ¶ [0084]) and I8 and I9 (combination of Figures 2 and 3 per Weese, ¶ [0084]).

§ XII.B.10 ([1e]). Every one of these images is formed based on using the motion model M2, which teaches the "displacement fields" of claim 7. §§ XII.B.10 ([1e]), XII.B.7 (claim 7). The '353 patent explains that constructing a final image by accounting for displacements from one phase to the next is one way to "combine[]" displacement fields. Ex-1001, 7:24-29. Weese's use of the motion model to form each image accounts for motion through each phase and therefore involves "combining said displacement fields," as recited in claim 8. §§ XII.B.9 ([1d]) (explaining motion model accounts for motion throughout the breathing cycle), XII.B.10 ([1e]), XII.B.7 (claim 7). My analysis of [1e] thus shows Weese discloses and renders obvious claim 8 ***thirteen*** different ways.

[286] For Figure 1, I5 and I6 are formed using I4. Weese, ¶¶ [0072]-[0075] (forming I5), [0076] (forming I6), Fig. 1. And I4 is formed by integrating M2's motion vectors over all states of motion which accounts for displacements from one phase to the next, i.e. "combining said displacement fields." Weese, ¶ [0069]; Ex-

1001, 7:24-29. Thus, forming **I5** and **I6** "comprises combining said displacement fields," as recited in claim 8. § XII.B.10 ([1e]).

[287] Also for Figure 1, forming **I7** "comprises combining said displacement fields" at least because it is based on **I5** and **I6**. Forming **I7** also comprises this limitation because Weese discloses using the motion model to de-blur **I6** and generate **I7**. Weese, Fig. 1; § XII.B.10 ([1e]).

[288] For Figure 2, **I8** is formed using the motion model **M2** to de-blur **I0**, which accounts for displacements from one phase to the next. Weese, ¶¶ [0078]-[0079], Fig. 2; § XII.B.10 ([1e]). Thus, forming **I8** "comprises combining said displacement fields," as recited in claim 8. § XII.B.10 ([1e]); *see* Ex-1001, 7:24-29. And because **I9** is based on **I8**, forming **I9** "comprises combining said displacement fields." Weese, Fig. 1; § XII.B.10 ([1e]).

[289] For the modified figure, **I5** is formed using **I4**, which integrates **M2**'s motion vectors, **I8** is formed using the motion model **M2** to de-blur **I5**, and **I9** is based on **I8**. Weese, ¶¶ [0069], [0072]-[0075], [0078]-[0080], Figs. 1-2; § XII.B.10 ([1e]). Accordingly, forming **I5**, **I8** and **I9** each "comprises combining said displacement fields," by accounting for displacement from one phase to the next. Weese, ¶¶ [0072]-[0075], [0078]-[0080], Figs. 1-2; § XII.B.10 ([1e]); *see* Ex-1001, 7:24-29.

[290] For Figure 3, **I10** is formed by reconstructing projections **P1** using **I4**, which integrates **M2**'s motion vectors. Weese, ¶¶ [0069], [0081]-[0083], Fig. 3. Accordingly, forming **I10** "comprises combining said displacement fields," by accounting for displacements from one phase to the next, which is one way Figure 3 discloses this claim. Weese, ¶¶ [0069], [0081]-[0083], Fig. 3; § XII.B.10 ([1e]); *see* Ex-1001, 7:24-29.

[291] Figure 3 discloses claim 8 four other ways because Weese explains Figure 3 may be combined "at will" with Figures 1 and 2 when using a combination PET-CT system such that **I10** plays the role of **I0**. Weese, ¶ [0084]. That is, forming **I6** and forming **I7** disclose claim 8 two ways, as explained above in reference to Figure 1. And forming **I8** and forming **I9** disclose claim 8 two more ways, for reasons explained in reference to Figure 2.

J. Claim 9

[9] The method of claim 7, wherein said forming displacement fields comprises:
estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields.

[292] In my opinion, Weese discloses "[t]he method of claim 7, wherein said forming displacement fields comprises: estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images,

said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields," as recited in claim 9.

[293] As explained in reference to claim 7, Weese's **M2** motion vector fields are displacement fields. Weese, ¶¶ [0063]-[0068]; § XII.H (claim 7).

[294] Also as explained, Weese discloses these fields are based on a movement estimate between "first images" **I2** and **I3**, which are extracted from sequence **IS** using "first measurements" from **motion sensor 15**. § XII.H (claim 7). Weese, ¶¶ [0031], [0057], [0063]-[0068], [0072]-[0074], [0078]-[0080]; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese), XII.B.3 ([1a-ii]), XII.H (claim 7). Weese accordingly discloses and renders obvious "estimating movement of the mobile object based, respectively, on said plurality of first images, . . . , [and] said plurality of first measurements. . . , in order to form said displacement fields," as recited in claim 9.

[295] Further, Weese's estimated movement of the motion vector fields are further derived from "second measurements" from sensor **S1** collected while capturing projections **P1** of "second images" **I0**. Weese, ¶¶ [0065]-[0067]; §§ XII.B.7 ([1c-ii])), XII.B.10 ([1e]). Weese accordingly discloses and renders obvious "estimating movement of the mobile object based, respectively, on . . . said plurality of second images, . . . and said plurality of second measurements, in order to form said displacement fields," as recited in claim 9.

K. Claim 10

[10] The method of claim 9, wherein at least one of said movement estimates is formed relative to a reference time.

[296] In my opinion, Weese discloses "[t]he method of claim 9, wherein at least one of said movement estimates is formed relative to a reference time," as recited in claim 10.

[297] Weese discloses obtaining the "actual motion" data from sensor **S1** to generate the state of motion function F1 used in motion estimates when forming its motion vectors. Weese, ¶¶ [0065]-[0067]. The state of motion function F1 employs a "reference time." Weese, ¶¶ [0065]-[0067], Figs. 4-5. For example, Weese's motion vectors are calculated relative to the parameter *r*, which is the state of motion derived from **S1**, and Weese expresses motion vector fields as a function of r, noting that the motion oscillates between r=0 and r=1, corresponding to "inhaled state" and "exhaled state" when tracking breathing, which are both "reference times," as recited in claim 10. Weese, ¶¶ [0065]-[0067].

L. Claim 11

[11] The method of claim 1, wherein the first sensor system is different from the second sensor system.

[298] In my opinion, Weese discloses "[t]he method of claim 1, wherein the first sensor system is different from the second sensor system," as recited in claim 11.

[299] As discussed, Weese describes embodiments that involve separate PET and CT systems. §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese). In my analysis, I show that Weese discloses every limitation of claim 1, for embodiments of Figure 1 that have a separate PET and CT systems as well as the modified figure I provided. § XII.B (claim 1). In these systems, **motion sensor 15** is the first sensor system of claim 1, and it is different from **S1**, which is the second sensor system. §§ XII.B.2 ([1a-ii]), XII.B.7 ([1c-ii]).

M. Claim 12

1. [12p] An apparatus to form an image of a mobile object, comprising:

[300] Weese discloses [12p], as discussed for [1p]. § XII.B.1 ([1p]).

2. [12a-i] means for obtaining a plurality of first images of the mobile object using a first imaging technique;

[301] Weese discloses [12a-i], as discussed for [1a-i]. § XII.B.2 ([1a-i]).

[302] Limitation [12a-i] would have been construed as a means-plus-function term and has the function "obtaining a plurality of first images of the mobile object using a first imaging technique." § IX.A.1 ([12a-i], claim construction). Weese discloses this function, as discussed for [1a-i]. § XII.B.2 ([1a-i]).

[303] The corresponding structure of this term includes an attenuation or emission radiation source and detector, gantry, processor, and memory. § IX.A.1 ([12a-i], claim construction). Weese discloses CT detectors (e.g., "detector unit 16")

in the context of a combination PET-CT system. Weese, ¶¶ [0053]-[0057], [0059]-[0061], Fig. 6. Weese also discloses other structures that also facilitate the function of obtaining first images, including a radiation source, gantry, computer, a reconstruction unit 10 for reconstructing images from projections, a control unit 7, and a data processing unit 23. *Id.* Weese teaches that these structures, including the detectors, would be present in a combined CT/PET apparatus and in a separated CT system. Weese, ¶¶ [0053], [0072]. Weese's system was conventional. § VII (TECHNOLOGICAL BACKGROUND).

[304] Accordingly, a POSITA would have understood Weese discloses a detector and radiation source that perform "obtaining a plurality of first images of the mobile object using a first imaging technique," as discussed for [1a-i]. § XII.B.2 ([1a-i]).

3. [12a-ii] means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images,

[305] Weese discloses and renders obvious [12a-ii], as discussed for [1a-ii]. § XII.B.3 ([1a-ii]).

[306] Limitation [12a-ii] would have been construed as a means-plus-function term and has the function "obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of

first images." § IX.A.2IX.A.1 ([12a-ii], claim construction). Weese discloses this function, as discussed for [1a-ii]. § XII.B.3 ([1a-ii]).

[307] The corresponding structure of this term includes a breathing, pressure, or electrocardiogram sensor. § IX.A.2IX.A.1 ([12a-ii], claim construction). Weese's motion sensor 15 is a sensor that performs "obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images," in embodiments with a combination PET-CT system and in embodiments with a separated CT system, as discussed for [1a-ii]. § XII.B.3 ([1a-ii]).

4. [12a-iii] the means for obtaining the plurality of first measurements being independent from the first imaging technique;

[308] Weese discloses [12a-iii], as discussed for [1a-iii]. § XII.B.4 ([1a-iii]).

5. [12b] means for associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

[309] Weese discloses [12b], as discussed for [1b]. § XII.B.5 ([1b]).

[310] The term "means for associating the plurality of first images with first movement states of the mobile object," as recited in limitation [12b], would have been construed as a means-plus-function term and has the function "associating the plurality of first images with first movement states of the mobile object." § IX.A.3

([12b], claim construction). Weese discloses this function, as discussed for [1b]. § XII.B.5 ([1b]).

[311] I have been asked to assume the corresponding structure includes a computer programmed to perform the associating. § IX.A.3 ([12b], claim construction). Weese discloses it. Weese's methods are carried out on computers. Weese, Abstract ("computer program"), ¶¶ [0001] (same), [0038] (same). It was conventional to use computers comprising processors and non-transitory memory for image processing in medical imaging at the time. Ex-1008, 61-93; *see* § VII (TECHNOLOGICAL BACKGROUND). Weese discloses an "image processing system" that is capable of receiving and processing image data. Weese, ¶ [0036]. Weese also discloses a "data processing unit" that runs a computer program, such as one on a portable storage medium. Weese, ¶¶ [0038], [0060], claim 10. Weese explains "[t]he data processing unit 23 is arranged to combine, using the method in accordance with the invention as well as the motion signal, the information contents of the CT images and the PET images, to reduce motion artifacts, if any, and to visualize the results accordingly by means of a display apparatus 11." Weese, ¶ [0060]. Weese also discloses "[a] computer readable medium containing instructions for controlling a data processing unit in such a manner that the data processing unit can carry out a method as claimed in claim 1." Weese, claim 12.

[312] Accordingly, a POSITA would have understood Weese discloses a computer programmed to perform "associating the plurality of first images with first movement states of the mobile object," as discussed for [1b]. § XII.B.5 ([1b]).

6. [12c-i] means for obtaining a plurality of second images of the mobile object using a second imaging technique;

[313] Weese discloses and renders obvious [12c-i], as discussed for [1c-i]. § XII.B.6 ([1c-i]).

[314] Limitation [12c-i] would have been construed as a means-plus-function term and has the function "obtaining a plurality of second images of the mobile object using a second imaging technique." § IX.A.4 ([12c-i], claim construction). Weese discloses this function, as discussed for [1c-i]. § XII.B.6 ([1c-i]).

[315] The corresponding structure of this term an attenuation or emission radiation source and detector, gantry, processor, and memory. § IX.A.4 ([12c-i], claim construction). Weese discloses PET detectors (e.g., "PET acquisition unit 20") in the context of a combination PET-CT system. Weese, ¶¶ [0047]-[0061], Fig. 6. Weese discloses other structures that also facilitate the function of obtaining first images, including a radiation source, gantry, computer, an evaluation unit 22 for reconstructing images from projections, a control unit 7, and a data processing unit 23. Weese, ¶¶ [0047]-[0051], [0058], Fig. 6. Weese teaches that these structures, including the detectors, would be present in a combined CT/PET

apparatus and in a separated PET system. Weese, ¶¶ [0053], [0072]; § XII.B.6 ([1c-i]). Weese's system was conventional. § VII (TECHNOLOGICAL BACKGROUND).

[316] Accordingly, a POSITA would have understood Weese discloses an attenuation or emission radiation source and detector, gantry, processor, and memory that perform "obtaining a plurality of second images of the mobile object using a second imaging technique," as discussed for [1c-i]. § XII.B.6 ([1c-i]).

7. [12c-ii] means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images,

[317] Weese discloses and renders obvious [12c-ii], as discussed above for [1c-ii]. § XII.B.7 ([1c-ii]).

[318] Limitation [12c-ii] would have been construed as a means-plus-function term and has the function "obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images." § IX.A.5 ([12c-ii], claim construction). Weese discloses this function, as discussed for [1c-ii]. § XII.B.7 ([1c-ii]).

[319] The corresponding structure of this term includes a breathing, pressure, or electrocardiogram sensor. § IX.A.5 ([12c-ii], claim construction). Weese's sensor S1 is a breathing sensor that performs "obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the

plurality of second images," in embodiments with a combination PET-CT system and in embodiments with a separated PET system, as discussed for [1c-ii]. § XII.B.7 ([1c-ii]).

8. [12c-iii] the means for obtaining the plurality of second measurements being independent from the second imaging technique;

[320] Weese discloses [12c-iii], as discussed for [1c-iii]. § XII.B.8 ([1c-iii]).

9. [12d] means for associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements; and

[321] Weese discloses [12d] for reasons provided for [1d]. § XII.B.9 ([1d]).

[322] The "means for associating the plurality of second images with second movement states of the mobile object" of [12d] would have been construed as a means-plus-function term and has the function "associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements." § IX.A.6 ([12d], claim construction). Weese discloses this function, as discussed for [1c-ii]. § XII.B.7 ([1c-ii]).

[323] Limitation [12d] requires "the second movement states being determined by the ***second*** measurements," while [1d] requires "associating the plurality of second images with second movement states of the mobile object using

the ***first*** measurements." But the same processes in Weese that disclose [1d] also disclose the function of [12d] because Weese's motion model M2 relies on "first measurements" from motion sensor 15 to extract CT images I2 and I3 and it relies on "second measurements" from sensor S1 to capture actual motion when collecting PET projections P1. *See* §§ XII.B.7 ([1c-ii], describing role of S1 to construct motion model M2), XII.B.9 ([1d] (describing association of "second images" I0 (or I10) with M2 and measurements from motion sensor 15). Hence, Weese discloses and renders obvious associating "second measurements" from S1 with the "second plurality of images" I0 (or I10) by using motion model M2 in Figures 1-3 and the modified figure in the same way using M2 associates I0 (or I10) with measurements from motion sensor 15. §§ XII.B.7 ([1c-ii]), XII.B.9 ([1d]). This holds true whether motion sensor 15 is the same as sensor S1 or different (e.g., embodiments with separate and independent PET and CT systems). §§ XII.B.7 ([1c-ii]), XII.B.9 ([1d]).

[324] I have been asked to assume the structure corresponding to the function "associating the plurality of second images with second movement states of the mobile object" includes a computer programmed to perform the associating. § IX.A.6 ([12d], claim construction). Weese discloses it. Weese's methods are carried out on computers. Weese, Abstract ("computer program"), ¶¶ [0001] (same), [0038] (same). It was conventional to use computers comprising processors and non-transitory memory for image processing in medical imaging at the time. Ex-

1008, 61-93; *see* § VII (TECHNOLOGICAL BACKGROUND). Weese discloses an "image processing system" that is capable of receiving and processing image data. Weese, ¶ [0036]. Weese also discloses a "data processing unit" that runs a computer program, such as one on a portable storage medium. Weese, ¶¶ [0038], [0060], claim 10. Weese explains "[t]he data processing unit 23 is arranged to combine, using the method in accordance with the invention as well as the motion signal, the information contents of the CT images and the PET images, to reduce motion artifacts, if any, and to visualize the results accordingly by means of a display apparatus 11." Weese, ¶ [0060]. Weese also discloses "[a] computer readable medium containing instructions for controlling a data processing unit in such a manner that the data processing unit can carry out a method as claimed in claim 1." Weese, claim 12; *see* Weese, claim 1.

[325] Accordingly, a POSITA would have understood Weese discloses a computer programmed to perform "associating the plurality of first images with first movement states of the mobile object," as discussed for [1d]. § XII.B.9 ([1d]).

10. [12e] means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,

[326] Weese discloses and renders obvious [12e], as discussed for [1e]. § XII.B.10 ([1e]).

[327] Limitation [12e] would have been construed as a means-plus-function term and has the function "forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states." § IX.A.7 ([12e], claim construction). Weese discloses this function, as discussed for [1e]. § XII.B.10 ([1e]).

[328] I have been asked to assume the corresponding structure includes a computer programmed to perform the forming. § IX.A.7 ([12e], claim construction). Weese discloses it. Weese's methods are carried out on computers. Weese, Abstract ("computer program", ¶¶ [0001] (same), [0038] (same). It was conventional to use computers comprising processors and non-transitory memory for image processing in medical imaging at the time. Ex-1008, 61-93; *see* § VII (TECHNOLOGICAL BACKGROUND). Weese discloses an "image processing system" that is capable of receiving and processing image data. Weese, ¶ [0036]. Weese also discloses a "data processing unit" that runs a computer program, such as one on a portable storage medium. Weese, ¶¶ [0038], [0060], claim 10. Weese explains "[t]he data processing unit 23 is arranged to combine, using the method in accordance with the invention as well as the motion signal, the information contents of the CT images and the PET images, to reduce motion artifacts, if any, and to visualize the results

accordingly by means of a display apparatus 11." Weese, ¶ [0060]. Weese also discloses "[a] computer readable medium containing instructions for controlling a data processing unit in such a manner that the data processing unit can carry out a method as claimed in claim 1." Weese, claim 12.

[329] Accordingly, a POSITA would have understood Weese discloses a computer programmed to perform "forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states," as discussed for [1e]. § XII.B.10 ([1e]).

11. [12f] wherein the first imaging technique is different from the second imaging technique.

[330] Weese discloses [12f], as discussed for [1f]. § XII.B.11 ([1f]).

N. Claim 13 [13] The apparatus of claim 12, further comprising: means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

[331] Weese discloses claim 13, as discussed for claim 3. § XII.D (claim 3).

[332] Claim 13 would have been construed as a means-plus-function term and has the function "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said

plurality of second images." § IX.A.8 (claim 13, claim construction). Weese discloses this function, as discussed for claim 3. § XII.D (claim 3).

[333] I have been asked to assume the corresponding structure includes a computer programmed to perform the forming. § IX.A.8 (claim 13, claim construction). Weese discloses it. Weese's methods are carried out on computers. Weese, Abstract ("computer program", ¶¶ [0001] (same), [0038] (same). It was conventional to use computers comprising processors and non-transitory memory for image processing in medical imaging at the time. Ex-1008, 61-93; *see* § VII (TECHNOLOGICAL BACKGROUND). Weese discloses an "image processing system" that is capable of receiving and processing image data. Weese, ¶ [0036]. Weese also discloses a "data processing unit" that runs a computer program, such as one on a portable storage medium. Weese, ¶¶ [0038], [0060], claim 10. Weese explains "[t]he data processing unit 23 is arranged to combine, using the method in accordance with the invention as well as the motion signal, the information contents of the CT images and the PET images, to reduce motion artifacts, if any, and to visualize the results accordingly by means of a display apparatus 11." Weese, ¶ [0060]. Weese also discloses "[a] computer readable medium containing instructions for controlling a data processing unit in such a manner that the data processing unit can carry out a method as claimed in claim 1." Weese, claim 12.

[334] Accordingly, a POSITA would have understood Weese discloses a computer programmed to perform "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images," as discussed for claim 3. § XII.D (claim 3).

O. Claim 14 [14] The apparatus of claim 12, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

[335] Weese discloses claim 14, as discussed for claim 5. § XII.F (claim 5).

P. Claim 15 [15] The apparatus of claim 12, further comprising: means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

[336] Weese discloses claim 15, as discussed for claim 7. § XII.H (claim 7).

[337] Claim 15 would have been construed as a means-plus-function term and has the function "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements." § IX.A.9 (claim 15, claim construction). Weese discloses this function, as discussed for claim 7. § XII.H (claim 7).

[338] I have been asked to assume the corresponding structure includes a computer programmed for forming displacement fields. § IX.A.9 (claim 15, claim

construction). Weese discloses it. Weese's methods are carried out on computers. Weese, Abstract ("computer program", ¶¶ [0001] (same), [0038] (same). It was conventional to use computers comprising processors and non-transitory memory for image processing in medical imaging at the time. Ex-1008, 61-93; *see* § VII (TECHNOLOGICAL BACKGROUND). Weese discloses an "image processing system" that is capable of receiving and processing image data. Weese, ¶ [0036]. Weese also discloses a "data processing unit" that runs a computer program, such as one on a portable storage medium. Weese, ¶¶ [0038], [0060], claim 10. Weese explains "[t]he data processing unit 23 is arranged to combine, using the method in accordance with the invention as well as the motion signal, the information contents of the CT images and the PET images, to reduce motion artifacts, if any, and to visualize the results accordingly by means of a display apparatus 11." Weese, ¶ [0060]. Weese also discloses "[a] computer readable medium containing instructions for controlling a data processing unit in such a manner that the data processing unit can carry out a method as claimed in claim 1." Weese, claim 12.

[339] Accordingly, a POSITA would have understood Weese discloses a computer programmed to perform "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements," as discussed for claim 7. § XII.H (claim 7).

Q. Claim 16 [16] The apparatus of claim 15, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields.

[340] Weese discloses claim 16, as discussed for claim 8. § XII.I (claim 8).

[341] Claim 16 would have been construed as a means-plus-function term and has the function "combining said displacement fields." § IX.A.10 (claim 16, claim construction). Weese discloses this function, as discussed for claim 8. § XII.I (claim 8).

[342] I have been asked to assume the corresponding structure includes a computer programmed for combining displacement fields. § IX.A.10 (claim 16, claim construction). Weese discloses it. The structure that corresponds to claim 16's function of "combining said displacement fields" is the structure that corresponds to limitation [12e]'s function of "forming an image of the mobile object" and claim 15's function of "forming displacement fields." §§ IX.A.7 ([12e]), IX.A.9 (claim 15).

[343] Accordingly, a POSITA would have understood Weese discloses a computer programmed for "combining said displacement fields," as discussed for claim 8. § XII.I (claim 8).

R. Claim 17 [17] The apparatus of claim 15, wherein said means for forming displacement fields comprises: means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first

measurements, and said plurality of second measurements, in order to form said displacement fields.

[344] Weese discloses claim 17, as discussed for claim 9. § XII.J (claim 9).

[345] Claim 17 would have been construed as a means-plus-function term and has the function "estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields." § IX.A.11 (claim 17, claim construction). Weese discloses this function, as discussed for claim 9. § XII.J (claim 9).

[346] I have been asked to assume the corresponding structure includes a computer programmed for estimating movement based on images and measurements. § IX.A.11 (claim 17, claim construction). Weese discloses it. The structure that corresponds to claim 17's function of "estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields" is the structure that corresponds to claim 15's function of "forming displacement fields." § IX.A.9 (claim 15).

[347] Accordingly, a POSITA would have understood Weese discloses a computer programmed for "estimating movement of the mobile object based,

respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields," as discussed for claim 9. § XII.J (claim 9).

S. Claim 18 [18] The apparatus of claim 17, wherein at least one of said movement estimates is to be formed relative to a reference time.

[348] Weese discloses claim 18, as discussed for claim 10. § XII.K (claim 10).

XIII. GROUND 2 (WEESE IN VIEW OF MUEHLLEHNER)

[349] In my opinion, claims 1-18 of the '353 patent are unpatentable over Weese in view of Muehllehner.

A. Ground 2 Overview: Weese in view of Muehllehner

[350] As I explained above for Ground 1, Weese's **PET image I0** and **I10** disclose and renders obvious a "plurality of second images," as recited in [1c-ii], because Weese discloses **I0** and **I10** are volume images in some embodiments. § XII.B.6.a ([1c-i]). Weese's PET volume images disclose and render obvious obtaining multiple 2D PET slices ("a plurality of second images") in order to construct a 3D image. § XII.B.6.a ([1c-i]).

[351] As I explained, Weese attempts to solve the problem of motion artifacts in "slice images or ***volume images*** of a moving object." Weese, ¶ [0002]. Weese's PET image **I0** and **I10** are "volume images" in some embodiments. Weese,

¶¶ [0002], [0026], [0048], [0058], [0061], [0084]. Weese repeatedly describes its PET images like **I0** and **I10** as conventional "volume images" using "known" techniques in some embodiments. For example, Weese discusses using "known . . . volume imaging" methods for CT and PET. Weese, ¶ [0026]; *see id.*, ¶ [0061]. Weese states "[t]he PET method is ***known*** from the field of nuclear medicine and is intended for the formation of slice images or ***volume images***," and "detected γ quanta forms a set of projections **P1** of the object wherefrom a slice image or ***volume image*** can be reconstructed in ***known*** manner during a subsequent reconstruction." Weese, ¶ [0048]. Weese "generates" such PET volume images from parallel rings of sensors using "***known*** algorithms." Weese, ¶ [0058].

[352] Throughout, Weese provides no specifics on how to create its 3D "volume images." Weese, ¶¶ [0002], [0026], [0048], [0058], [0061]. This, of course, is because a POSITA would have been familiar with known ways to create volume images, so Weese did not need to elaborate on these admittedly known, standard techniques. *E.g.*, Weese, ¶¶ [0026], [0048], [0058]. In my opinion, given the background knowledge of a POSITA, it would have been obvious that Weese's 3D PET "volume images" would have been based on a "plurality of second images" as recited in [1c-i]. § XII.B.6.a ([1c-i]).

[353] Nevertheless, to the extent that Patent Owner disputes that "obtaining a plurality of second images" would have been obvious over Weese's PET volume

images and the background knowledge of a POSITA, this limitation would also have been obvious over Weese in view of Muehllehner.

[354] A POSITA in possession of Weese would have looked to Muehllehner for further details on how to construct PET volume images. As I pointed out, Weese does not provide such details. *E.g.*, Weese, ¶¶ [0002], [0026], [0048], [0058], [0061]. Muehllehner describes forming three-dimensional PET volume images from two dimensional slices. Muehllehner, Abstract, 1:65-2:14, 12:48-60, 13:18-38 (claim 1), Figs. 2, 2a, 11-13. The Weese-Muehllehner combination employs Muehllehner's post-data collection process techniques to make Weese's PET volume images I0 and I10 and otherwise leaves Weese's methods unchanged. That is, images formed based on I0 or I10 (e.g., I5, I6, I7, I8, and I9) are formed in the same way in the Weese-Muehllehner combination as with Weese alone as discussed in Ground 1 in the context of Figs. 1-3 and the modified figure I provided in Ground 1. § XII (Ground 1 (Weese)).

[355] A POSITA would have found Muehllehner a suitable option for predictably reconstructing Weese's PET volume images because it provides an example of a "known algorithm" for creating PET volume images that Weese mentions but does not describe. Weese, ¶¶ [0026], [0048], [0058]. Muehllehner discloses using all the same equipment Weese uses to collect slice PET projections and reconstruct PET images, including detectors, a gantry, and a computer system.

E.g., Muehllehner, 3:27-58, Fig. 1; Weese, ¶¶ [0047]-[0051], [0058], Fig. 6; §§ XII.B.6 (Ground 1, [1c-i]), XII.M.6 (Ground 1, [12-ci], identifying Weese's structure corresponding to function of "obtaining a plurality of second images using a second imaging technique."). A POSITA would have accordingly found the implementation of Muehllehner's image processing methods for PET projections in Weese's system would have predictably led to reconstructed PET volume images.

[356] In addition, a POSITA would have employed Muehllehner's methods to predictably reduce blurring in the z-direction based on the physics of PET acquisition, which is independent from any motion-based blurring. Weese and Muehllehner are both directed to the problem of reducing blurring in PET images. *E.g.*, Weese, ¶¶ [0002]-[0004], [0049]; Muehllehner, Abstract, 1:13-63. Muehllehner teaches an "axial filtering" method that "eliminates unacceptable blurring in the reconstructed volume." Muehllehner, 6:49-9:3 (describing image filtering and sinogram filtering). This approach involves processing projection data (e.g., rebinning two-dimensional data and filtering) of the sort that Weese also collects (e.g., projections P1). *See id.*; Weese, ¶¶ [0047]-[0051], [0058], Figs. 1-3. Therefore, a POSITA would have had a reasonable chance of success in reducing blurring when implementing Muehllehner's two-dimensional iterative reconstruction algorithm to process Weese's projections.

[357] In addition, a POSITA would have used Muehllehner's three-dimensional reconstruction methods when making volume images I0 and I10 to improve efficiency. For example, Muehllehner discloses its methods "reduce the overall time required for collecting and reconstructing data" because it employs multi-slice rebinning of projection data and axial filtering. Muehllehner, 10:60-64. Muehllehner explains this method saves time and reduces cost as compared to other known 3D imaging techniques at the time. Muehllehner, 2:39-63 (identifying goal to reduce time and cost of PET collection), 10:54-67, 11:24-30. A POSTIA would have found it predictable that Muehllehner's straightforward image reconstruction would have reduced time and cost of PET collection.

[358] In my opinion, claims 1-18 are obvious over Weese in view of Muehllehner. The Weese-Muehllehner combination employs Muehllehner's post-data collection process techniques to make Weese's PET volume images I0 and I10 and otherwise leaves Weese's systems and methods unchanged. Hence, my analysis remains unchanged from Ground 1 for all limitations other than limitations [1c-i] and [12c-i], which involve "obtaining a plurality of second images using a second imaging technique." For Ground 2, I provide only an analysis of limitations [1c-i] and [12c-i]. For all other limitations, Weese in view of Muehllehner renders the claims obvious for the same reasons provided for Weese alone in Ground 1. § XII (Ground 1 (Weese)).

B. [1c-i] obtaining a plurality of second images of the mobile object using a second imaging technique

[359] As described above for Ground 1, Weese's volume images I0 and I10 are "a plurality of second images of the mobile object using a second imaging technique." § XII.B.6 (Ground 1, [1c-i]). A POSITA would have been motivated to combine Weese and Muehllehner and use Muehllehner's methods of forming 3D PET images to generate I0 and I10. § XIII.A (Ground 2 Overview: Weese in view of Muehllehner). That method involves collecting a plurality of two-dimensional slices, then applying a "two-dimensional iterative reconstruction algorithm . . . to reconstruct a three-dimensional image, slice-by-slice." Muehllehner, 2:10-14, 6:63-9:3, 11:48-63, 13:18-39 (claim 1). This general approach was widely implemented in combined PET-CT systems at the time of the '353 patent. *E.g.*, Ex-1020, ¶ [0081] ("slice-by-slice" volume imaging approach).

[360] For example, Muehllehner's Figures 2 and 2a (shown below) provide alternative methods that both explicitly disclose creating a "plurality of second images." In the "imaging filtering" approach, step 42 involves "Reconstruct[ing] a Set of Images for the Set of Sinograms Using a 2-D Algorithm (Preliminary images)." Muehllehner, 4:10-25, Figs. 2-2a. In the "sinogram filtering" approach, step 50 involves "Reconstruct[ing] a Set of Images for the Set of Sinograms Using

a 2-D Algorithm." Muehllehner, 4:10-25, Figs. 2-2a. Both methods thus involve creating a plurality of second images when creating a PET volume image.

[361] Weese in view of Muehllehner therefore renders obvious [1c-i].

FIG. 2

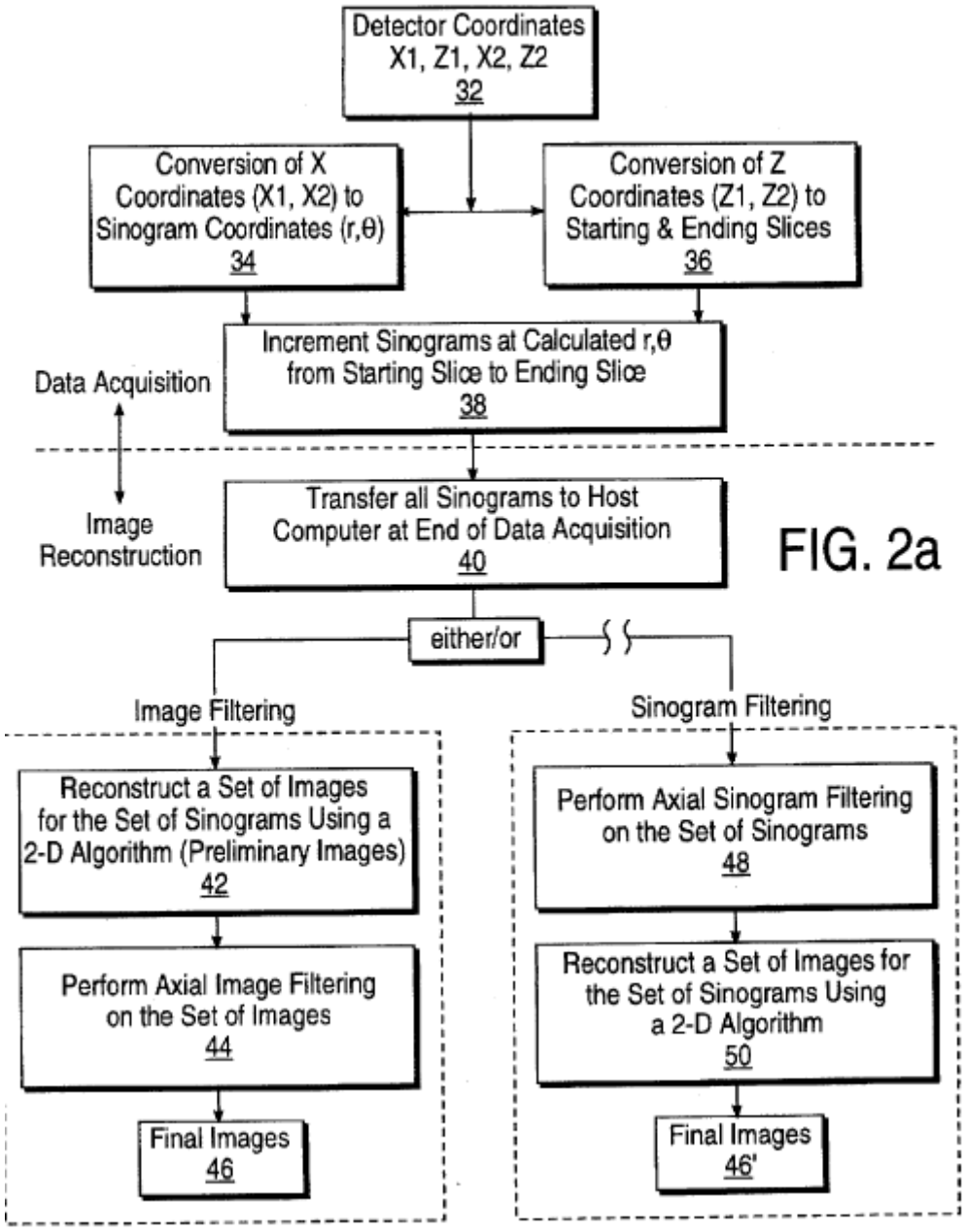


FIG. 2a

Muehllehner, Figs. 2-2a

C. [12c-i] means for obtaining a plurality of second images of the mobile object using a second imaging technique;

[362] Weese in view of Muehllehner renders obvious [12c-i], as discussed for [1c-i]. § XIII.B ([1c-i]).

[363] Limitation [12c-i] would have been construed as a means-plus-function term and has the function "obtaining a plurality of second images of the mobile object using a second imaging technique." § IX.A.4 ([12c-i], claim construction). Weese discloses this function, as discussed for [1c-i]. § XIII.B ([1c-i]).

[364] The corresponding structure of this term includes an attenuation or emission radiation source and detector, gantry, processor, and memory. § IX.A.4 ([12c-i], claim construction). Weese discloses PET detectors (e.g., "PET acquisition unit 20") in the context of a combination PET-CT system. Weese, ¶¶ [0047]-[0061], Fig. 6. So does Muehllehner. Muehllehner, 1:66-2:14, 3:27-58, Fig. 1. Weese discloses other structures that also facilitate the function of obtaining first images, including a radiation source, gantry, computer, an evaluation unit 22 for reconstructing images from projections, a control unit 7, and a data processing unit 23. Weese, ¶¶ [0047]-[0051], [0058], Fig. 6. So does Muehllehner. *E.g.*, Muehllehner, 3:27-58, Fig. 1. Weese teaches that these structures, including the detectors, would be present in a combined CT/PET apparatus and in a separated PET

system. Weese, ¶¶ [0053], [0072]; § XII.B.6 ([1c-i]). The systems of Weese and Muehllehner were conventional. § VII (TECHNOLOGICAL BACKGROUND).

[365] Accordingly, a POSITA would have understood Weese in view of Muehllehner renders obvious an attenuation or emission radiation source and detector, gantry, processor, and memory that perform "obtaining a plurality of second images of the mobile object using a second imaging technique," as discussed for [1c-i]. § XIII.B ([1c-i]).

XIV. GROUND 3 (WEESE IN VIEW OF WAINER)

A. Ground 3 Overview: Weese in view of Wainer

[366] A POSITA would have used Wainer's gating to reduce motion artifacts in Weese's PET image **I0** to improve reliability and precision of image information when combining PET and CT images. Both references address the need for better matching between structural images (e.g., CT) and functional images (e.g., SPECT, PET) by removing motion artifacts and matching images collected using different modalities at the same motion state. *E.g.*, Weese, Title, Abstract, ¶¶ [0001]-[0038], [0047], Figs. 1-3; Wainer, 1:10-15, 2:3-21, 3:33-60 (gating to remove object "smearing"), 8:38-49. They teach compatible and interchangeable ways to reduce motion artifacts for image combination: Weese uses a motion model to "focus[]" unsharp images to one motion state (Weese, ¶¶ [0020]-[0022], [0033], [0071], [0077]-[0080], Figs. 1-2) while Wainer achieves the same result by gating data

collection to create images corresponding to specific phases of "body rhythms" (Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6).

[367] As I previously explained, Weese generally teaches a flexible approach to correcting motion artifacts and combining CT and PET images. *E.g.*, Weese, Abstract, ¶¶ [0013] (generally teaching to use motion data "in various ways in supplementary image processing or image forming steps, resulting in a higher quality of the resultant images."), [0018]-[0019] (interchanging approaches), [0029] (combining claims 1 and 3 or claims 2 and 3), [0080] (combining aspects of Figs. 1-2), [0084] (combining aspects of Figs. 1-3), Figs. 1-3 (containing features common to all three figures); *see* §§ X.A (Overview of Weese (U.S. 2005/0226527)), X.A.2 (Weese Flexibly Describes Many Ways to Combine CT and PET Images to Correct Motion Artifacts). Weese's flexibility provides advantages. Weese extols the value of employing more than one method of image correction and fusion. Physicians would have "desire[d]" various views of combination images "to enable comparison or a combination of information [in an unaltered image] with information from other [motion corrected] images." Weese, ¶ [0075]. And Weese states generally that "[i]t is an object of the invention to increase the information content of images containing motion artifacts," which motivates its flexible approach. Weese, ¶ [0004]. In light of Weese's flexible approach to reaching its goals, a POSITA would have been

motivated to look for other methods to improve reliability and precision of image information when combining PET and CT images.

[368] Wainer describes one such method. Wainer discloses a simple approach to gating that was entirely conventional at the time—grouping projections into time bins associated with different motion states determined from sensor data and reconstructing images for each phase of a repetitive cycle (e.g., breathing or cardiac cycle). *E.g.*, Wainer, 3:33-60 (disclosing gating methods for "body rhythms"), 4:56-61 (same), 8:38-59 (gated CT and gated STET images), 8:60-9:20 (discussing Fig. 6), Fig. 6. Gating helps reduce motion-induced "smearing" in images and it facilitates registration of images taken with different modalities. Wainer, 3:33-60, 8:38-59. Wainer's approach is textbook gating. *E.g.*, Ex-1008, 452 (Bushberg textbook on gating for MRI), 696-698 (gating in nuclear medicine). A POSITA would have used Wainer's gating in Weese's system to satisfy Weese's goal to "increase the information content of images containing motion artifacts" and combine structural and functional images with fewer artifacts. Weese, ¶¶ [0004], [0019], [0052].

[369] Weese explains lengthy PET projection collection times lead to motion artifacts, and differences in body position due to "natural breathing" during PET may make PET images incompatible with CT images collected under typical "unnatural or cramped" conditions. Weese, ¶¶ [0047]-[0051], [0062]; *see* Ex-1015,

605 (discussing differences between tidal breathing during PET and CT breath-hold techniques); Ex-1016 (identifying need for breathing protocols to reduce artifacts when merging PET and CT images). Weese thus acknowledges the need to account for the same motion processes when merging CT and PET images. Weese, ¶ [0062]. Wainer's gating would have been an obvious, well-known, and suitable choice for a POSITA to account for motion in PET images when combining CT and PET images.

[370] In fact, Weese suggests using gating. Weese describes collecting a "sequence of CT images IS of the respiratory motion can be acquired during which the object ***performs the same motion*** as during the acquisition of the [PET] projections P1" and describes extracting CT images I2 and I3 from the sequence at specific motion states "using ***known methods***." Weese, ¶[0062], [0079], Figs. 1-2. These "known methods" would have included gating, which was common and long known at the time (§ VII (TECHNOLOGICAL BACKGROUND), because the purpose of gating is to extract images at specific motion states from a time-sequence of projections. *E.g.*, Ex-1008, 452, 696-698; Ex-1011, 367; Ex-1012, 1924; Ex-1014, 1420, Ex-1017, 849 (1994 CT study describing post-image acquisition respiratory gating). Weese thus teaches and suggests using gating techniques for its CT images. It would not have been an inventive leap for a POSITA to apply the same techniques to Weese's PET images given that Weese already stresses the need

to match motion states prior to combining PET and CT images. Weese, ¶¶ [0020]-[0022], [0033], [0071], [0077]-[0080], Figs. 1-2.

[371] Further, in view of these disclosures, a POSITA would have additionally found it obvious to use Wainer's gating of CT images to better match motion states for combining PET and CT images. Wainer teaches gating structural transmission images, including CT images, when combining structural and functional imaging techniques. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. Wainer calls this approach "preferable." *Id.* Wainer explains this facilitates registration between structural and functional images, which can be combined at the same phase of repetitive motion state. *Id.* Wainer states "[a] transmission image of a patient which is gated to body rhythms can be automatically registered to its corresponding gated emission image, since most of the misalignment between the two images is caused by body rhythms which are, in general repetitive." Wainer, 3:56-60. It would have been obvious to use Wainer's gating of structural images to achieve these benefits. Weese already expresses the goal of matching motion states when combining images, as I note above. Weese, ¶¶ [0020]-[0022], [0033], [0071], [0077]-[0080], Figs. 1-2. Gating both structural and functional images as Wainer teaches would have been an obvious and predictable way to meet Weese's goal.

[372] Wainer's functional image gating also solves a problem that Weese poses by using a sensor-based approach consistent with Weese's disclosure. Weese

describes the problem of focusing unsharp PET images on a motion state corresponding to a motion state of a CT image. Weese, ¶¶ [0020]-[0022], [0033], [0071], [0077]-[0080], Figs. 1-2. Weese teaches such focusing "is possible when the motion leading to the unsharp representation ***is known***," and uses a motion model to "***know***[]" that motion. Weese, ¶ [0022] (motion model to focus images). Weese discloses deriving the motion model from sensor data that ***knows*** an "actual motion process." Weese, ¶¶ [0031], [0057], [0065]. A POSITA would have accordingly found it obvious to use Wainer's gating in Weese's system to obtain a focused PET image because gating provides the sensor-based knowledge of body motions that Weese seeks. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6.

[373] In view of Weese, a POSITA would have found it obvious to employ Wainer's gating techniques to improve the sharpness of PET images and better align PET images with CT images. Weese already articulates the goal of focusing or sharpening PET images to one motion state, and a POSITA would have found gating a suitable option to achieve the same result Weese describes—representing "only one state of motion" with reduced artifacts. Weese, ¶¶ [0022], [0077]-[0080]. As I explained, gating groups projections (e.g., P1) into time bins associated with different motion states, such as different phases of breathing or cardiac cycle. *E.g.*, Wainer, 3:33-60 (disclosing gating methods for "body rhythms"), 8:38-9:20, Fig. 6; § VII (TECHNOLOGICAL BACKGROUND). Wainer teaches it is ***preferable*** to

gate both structural CT images and functional images (STET), which better "synchronize[s]" these images when combining them. Wainer, 8:38-49. This helps "correct organ motion" and improves image registration. Wainer, 8:50-59. Wainer also explains the "advantage is the ability to register transmission images to emission images even when they are not acquired simultaneously" while accounting for "most of the misalignment" between images. 3:51-60. A POSITA would have used Wainer's gating of structural and functional images as a suitable option in Weese's system to achieve these benefits. Weese, ¶¶ [0022], [0077]-[0080]; Wainer, 3:33-60, 8:38-9:20, Fig. 6. The combination would represent "only one state of motion" in Weese's PET images I0 that correspond to the CT images I2 or I3, just like Weese's original implementation that used "focusing," which was one way to obtain a "state of motion."*See* Weese, ¶¶ [0022], [0077]-[0080].

[374] Moreover, a POSITA would have used Wainer's gating during PET data collection because it would have improved the representation of one motion state in a PET image over Weese's focusing methods—i.e., a POSITA would have gated PET images then focused those gated PET images for improved image quality with less noise. Weese's "focusing" to one motion state involves executing a known image processing "focusing algorithm" in conjunction with a motion model. Weese, ¶¶ [0033], [0077] (identifying 1989 paper disclosing focusing algorithm). Weese derives its motion model in part from CT data. Weese, ¶¶ [0063]-[0067] (motion

model in part based on I2 and I3), Figs. 1-3. Yet CT data are collected at a different time and even from a different instrument than PET data in Weese. Weese, ¶¶ [0010], [0072]-[0074] (separate PET and CT systems), [0080] (same). And Weese recognizes CT collection conditions are often markedly different from PET conditions and their combination contains artifacts without motion correction, which was commonly understood. Weese, ¶¶ [0062] ("unnatural" motion states in CT in contrast to those of "natural respiratory motion" found in PET); *see* Wainer, 3:33-60, 8:38-59 (using gating to correct smearing); Ex-1015, 605 (discussing differences between tidal breathing during PET and CT breath-hold techniques), Ex-1016 (identifying need for breathing protocols to reduce artifacts when merging PET and CT images). Numerous studies, including those involving real human subjects, showed that gating improves the representation of one motion state in an image. Ex-1008, 453, 696-699; Ex-1012, 1923-24; Ex-1013, 876-877; Ex-1014, 1420. Wainer also touts these benefits, explaining that gating for two modalities improves alignment when combining images. Wainer, 3:33-60, 8:38-59.

[375] A POSITA also would have looked to Wainer for its teaching to simultaneously gate images for both cardiac and respiratory motion. Wainer, ¶¶ 2:18-19, 8:60-9:3 ("FIG. 6 indicates in simplified block diagram form a STET system 21 equipped to accomplish either cardiac or respiratory gating ***or both***."), Fig. 6. Weese teaches that cardiac and respiratory motion produce imaging artifacts.

Weese, ¶¶ [0009], [0049]-[0051], [0062]-[0063], [0065], Fig. 4. These body rhythms both contribute to motion artifacts and occur at very different time scales, which was a well-recognized problem in the field when imaging chest anatomy and dual gating was known. Ex-1008 (Bushberg textbook), 452-453 (describing dual "cardiac and respiratory gating" as "complementary"); Ex-1016, 589 ("Ideally, in a combined tomograph, both CT and PET data should be acquired ***during the same respiratory (and cardiac) cycle***."); Ex-1020, ¶ [0109] ("respiration and cardiac motion may result in some intrinsic misalignment" in combined PET/CT images of a thorax). A POSITA would have followed Wainer's teachings of grouping projections to account for both cardiac and respiratory motion to address the problem of motion artifacts arising under these different time scales. Wainer teaches gating removes object "smearing," assists with registration of emission and transmission images, and allows binned data to be more easily combined. Wainer, 1:10-15, 2:3-21, 3:33-60, 8:38-9:20. Wainer discloses a simple system that includes a **position sensor** on the patient's chest for **respiratory gating** and **cardiac sensor** for **cardiac gating** based on R waves of the heart. Wainer, 9:6-20, Fig. 6.

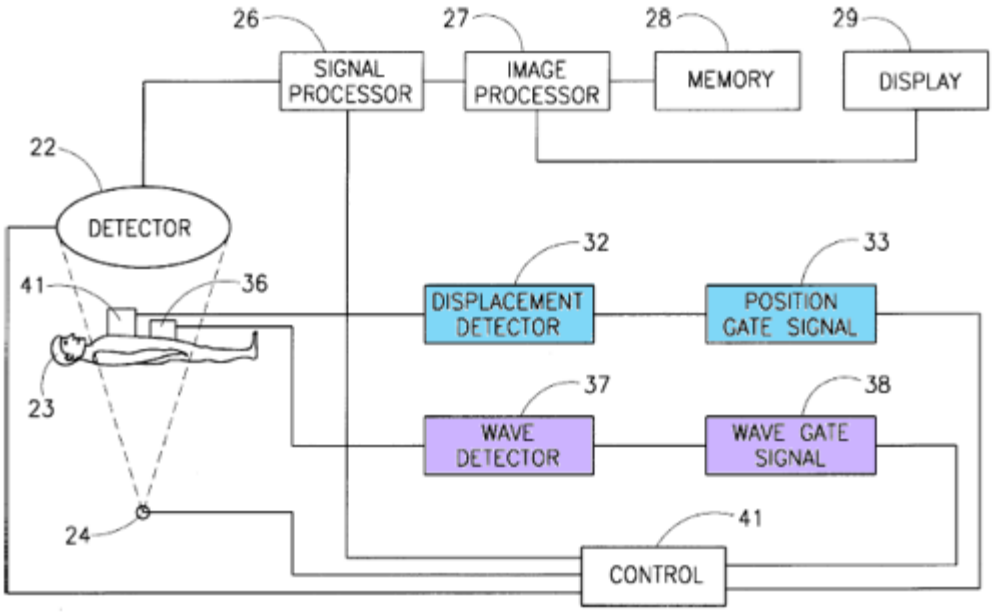


FIG.6

Wainer, Fig. 6 (annotated)

[376] A POSITA would have had a reasonable expectation of success when implementing Wainer's gating in Weese's system. As I have already explained, gating was known when collecting image projections like Weese's projections P1. § VII (TECHNOLOGICAL BACKGROUND); Ex-1008, 696-699 (gating in "nuclear medicine," like PET); Ex-1012; Ex-1013; Ex-1014; Ex-1014. Further, Wainer's gating achieves the same result Weese seeks through "focusing"—representing one motion state. Weese, ¶¶ [0022], [0031], Figs. 1-2. Weese uses the same classes of hardware to collect projections that would have been used for Wainer's gated approach, namely a radiation source, a gantry, detectors, a computer system, and sensors. Weese, ¶¶ [0047]-[0051], [0058], Fig. 6; Wainer, 8:60-9:3,

Fig. 6. No additional hardware would have been needed to make the combination. And Wainer discloses its methods are suitable for other types of structural and functional imaging techniques. Wainer, 9:24-31. Accordingly, Wainer's approach of time-binning projections based on sensor data would have predictably led to success when implemented in Weese's PET and CT system.

B. Claim 1

[377] In my opinion, claim 1 is obvious over Weese in view of Wainer.

1. [1p] A method of forming an image of a mobile object, comprising:

[378] Weese in view of Wainer renders obvious [1p].

[379] As discussed for Ground 1, Weese discloses "a method of forming an image of a mobile object," as recited in [1p]. § XII.B.1 ([1p]). For example, Weese at Figure 2 discloses a method to form images IS, I0, I2, I3, I8, and I9, which are images of a mobile object. Weese, ¶¶ [0047]-[0051], [0062], [0078]-[0080], Fig. 2.

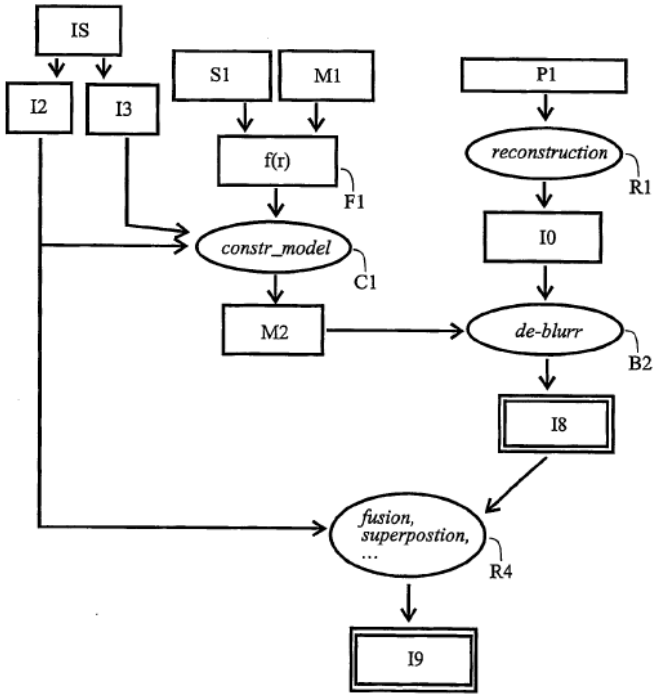


FIG.2

Weese, Fig. 2

[380] Accordingly, Weese in view of Wainer renders obvious [1p].

2. [1a-i] obtaining a plurality of first images of the mobile object using a first imaging technique;

[381] Weese in view of Wainer renders obvious [1a-i].

[382] As discussed for Ground 1, Weese discloses "obtaining a plurality of first images of the mobile object using a first imaging technique," as recited in [1a-i]. § XII.B.2 ([1a-i]). Weese teaches using CT techniques (a "first imaging technique" of [1a-i]) to acquire CT image sequence **IS** and CT images **I2** and **I3**, which are a "plurality of first images of the mobile object," as recited in [1a-i].

Weese, ¶¶ [0003], [0052], [0062], [0078]-[0080], [0083], Figs. 1-3; § XII.B.2 ([1a-i]).

[383] Accordingly, Weese in view of Wainer renders obvious [1a-i].

3. [1a-ii] while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system;

[384] Weese in view of Wainer renders obvious [1a-ii].

[385] As discussed for Ground 1, Weese discloses "obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system," as recited in [1a-ii], while "obtaining a plurality of first images of the mobile object using a first imaging technique" as recited in [1a-i]. § XII.B.3 ([1a-ii]).

[386] In the Weese-Wainer combination, a POSITA would have found it obvious to employ Wainer's CT gating methods to improve the information content of its images and better match motion states when combining CT and PET. § XIV.A (Ground 3 Overview: Weese in view of Wainer). Weese discloses using **motion sensor 15** to obtain a plurality of measurements corresponding to patient organ movements while obtaining sequence **IS** and images **I2** and **I3** using a **CT apparatus** (including radiation source S, collimator arrangement 3, detector unit 16, and reconstruction unit 10). Weese, ¶¶ [0053]-[0057].

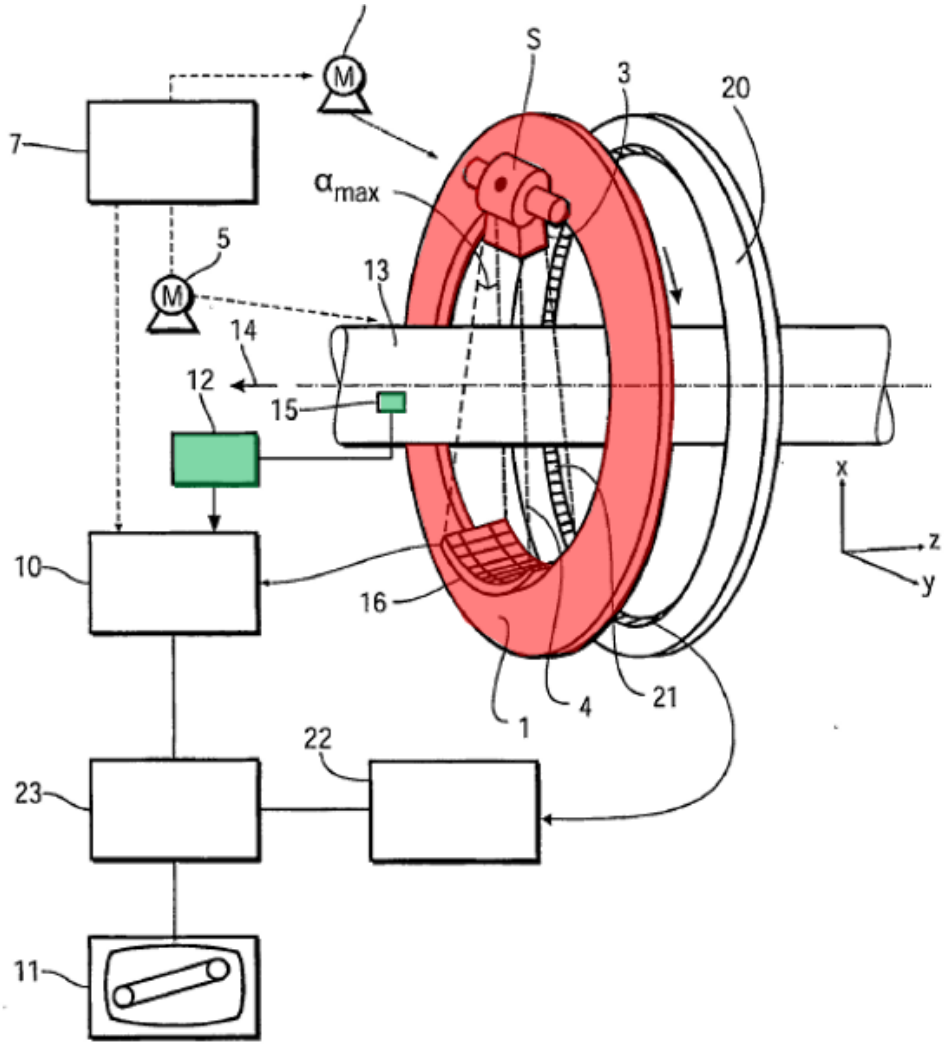


FIG.6

Weese, Fig. 6 (annotated)

[387] Wainer also employs sensors. Wainer uses position sensor 31 and **displacement detector 32** for respiratory gating and sensor 36 and **wave detector 37** for cardiac gating. Wainer, 9:6-20, Fig. 6. Wainer discloses performing both cardiac and respiratory gating when collecting images. *Id.* It would have been obvious to use Wainer's sensor systems for respiratory and cardiac gating in Weese's

system, which already includes a sensor (**motion sensor 15**), to achieve the benefits of Wainer's gating, including reduced motion artifacts and improved matching between structural (CT) and functional images (PET). § XIV.A (Ground 3 Overview: Weese in view of Wainer). Wainer's sensor-based gating approach would have been a simple substitution in Weese's system that would have been predictably implemented, as I have previously discussed. § XIV.A (Ground 3 Overview: Weese in view of Wainer).

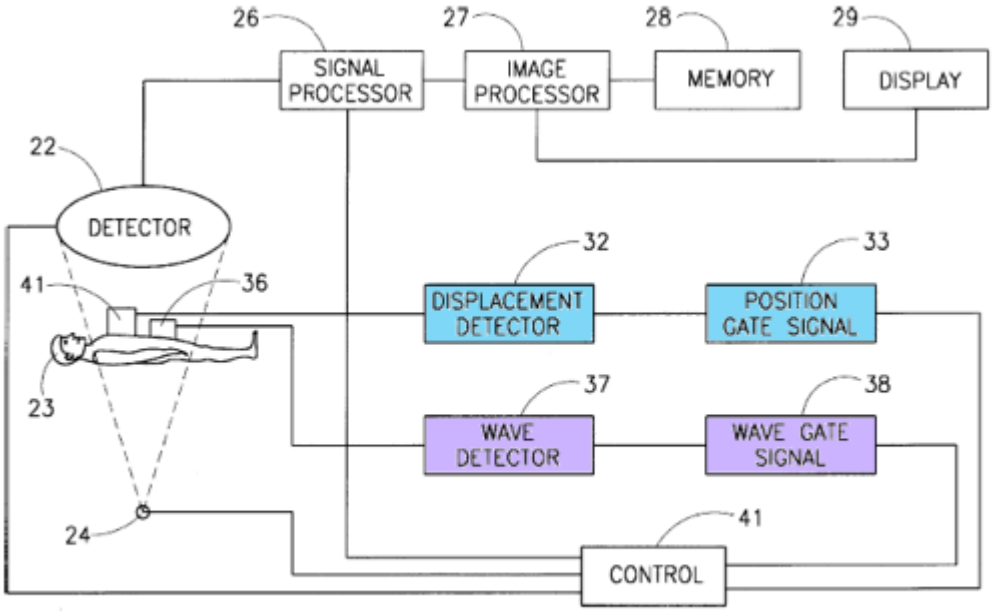


FIG.6

Wainer, Fig. 6 (annotated)

[388] In the combination, position sensor 31 and **displacement detector** is a "first sensor system" that obtains "first measurements" (position measurements) for

CT gating when collecting CT transmissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; § XIV.A (Ground 3 Overview: Weese in view of Wainer).

[389] Accordingly, Weese in view of Wainer renders obvious [1a-ii].

4. [1a-iii] the first sensor system being independent from the first imaging technique;

[390] Weese in view of Wainer renders obvious [1a-iii].

[391] As discussed for Ground 1, Weese discloses "the **first sensor system** being independent from the first imaging technique," as recited in [1a-iii]. § XII.B.4 ([1a-iii]). In the Weese-Wainer combination, the position sensor 31 and **displacement detector** is a "first sensor system" that monitors position for CT gating. § XII.B.3 ([1a-ii]). The position sensor 31 and **displacement detector** are independent from CT acquisition because they measure patient motion, not CT transmissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6.

[392] Accordingly, Weese in view of Wainer renders obvious [1a-iii].

5. [1b] associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

[393] Weese in view of Wainer renders obvious [1b].

[394] The Weese-Wainer combination uses Wainer's CT gating approach. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. §§ XIV.A (Ground 3 Overview: Weese in view of Wainer); XIV.B.2-4 ([1a-i]-[1a-iii]).

[395] Wainer explains "[t]he sensed displacement is operated on to provide windows or bins using a displacement detector 32." Wainer, 9:7-20. "In such gated images[,] data acquired during the imaging process is binned (or windowed) according to a gating signal derived from the body rhythm." Wainer, 4:56-61. These bins or windows correspond to phases of repetitive cycle (e.g., breathing), which allows for improved organ motion correction. Wainer, 3:51-60, 8:50-59. By binning or windowing CT data according to sensed displacement, Wainer discloses "associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements."

[396] Accordingly, Weese in view of Wainer renders obvious [1b].

6. [1c-i] obtaining a plurality of second images of the mobile object using a second imaging technique

[397] In my opinion, Weese in view of Wainer renders obvious "obtaining a plurality of second images of the mobile object using a second imaging technique" as recited in [1c-i].

[398] First, PET is a "second image technique," as recited in [1c-i]. Weese, ¶¶ [0048]-[0051], [0070], [0072], [0078]-[0084], Figs. 1-3. Then, Weese in view of Wainer renders obvious a "plurality of second images" because the combination creates a series of PET images **I0** corresponding to different phases of a breathing and/or cardiac cycle. § XIV.A (Ground 3 Overview: Weese in view of Wainer). For

example, Wainer discloses "image acquisition is gated to body rhythms and motions" and puts projections into separate bins (or windows). Wainer, 3:33-60. When implemented in Weese's system, Wainer's process of binning creates a "plurality of second images" **I0** for different phases of a motion (e.g., breathing or cardiac cycle). Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; § XIV.A (Ground 3 Overview: Weese in view of Wainer).

[399] The combination also renders obvious [1c-i] because both references disclose obtaining a plurality of 2D slices in a scan. Weese's method creates a set of planar slices by scanning a body along an axis parallel to the gantry on which a patient lies. Weese, ¶ [0053]-[0058], Fig. 6. Wainer also describes collecting a plurality of functional image 2D slices. Wainer, 4:34-55, 6:54-61, 7:10-25.

[400] Accordingly, Weese in view of Wainer renders obvious [1c-i].

7. [1c-ii] while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system

[401] In my opinion, Weese in view of Wainer renders obvious "obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system," as recited in [1c-ii], while "obtaining a plurality of first images of the mobile object using a first imaging technique" as recited in [1c-i].

[402] It was known at the time of the '353 patent to use sensor systems to monitor motion during CT and PET data collection, as I explained above. *See* § VII

(TECHNOLOGICAL BACKGROUND). The '353 patent did not invent that approach.

[403] The combination of Weese and Wainer calls for gating PET data collection and grouping projections into windows or bins associated with a phase of a breathing or cardiac cycle, based on sensor measurements. § XIV.A (Ground 3 Overview: Weese in view of Wainer). Wainer employs a position sensor 31 and **displacement detector 32** for respiratory gating and a sensor 36 and **wave detector 37** for cardiac gating. Wainer, 9:6-20, Fig. 6. Wainer teaches using both types of gating for the same images. *Id.* It would have been obvious to use Wainer's displacement detector and wave detector in Weese's system, which already includes a sensor (e.g., sensor S1), to achieve the benefits of gating, including reduced motion artifacts and improved matching between structural (CT) and functional images (PET). § XIV.A (Ground 3 Overview: Weese in view of Wainer). Wainer's sensor-based gating approach would have been a simple substitution in Weese's system that would have been predictably implemented, as I have previously discussed. § XIV.A (Ground 3 Overview: Weese in view of Wainer).

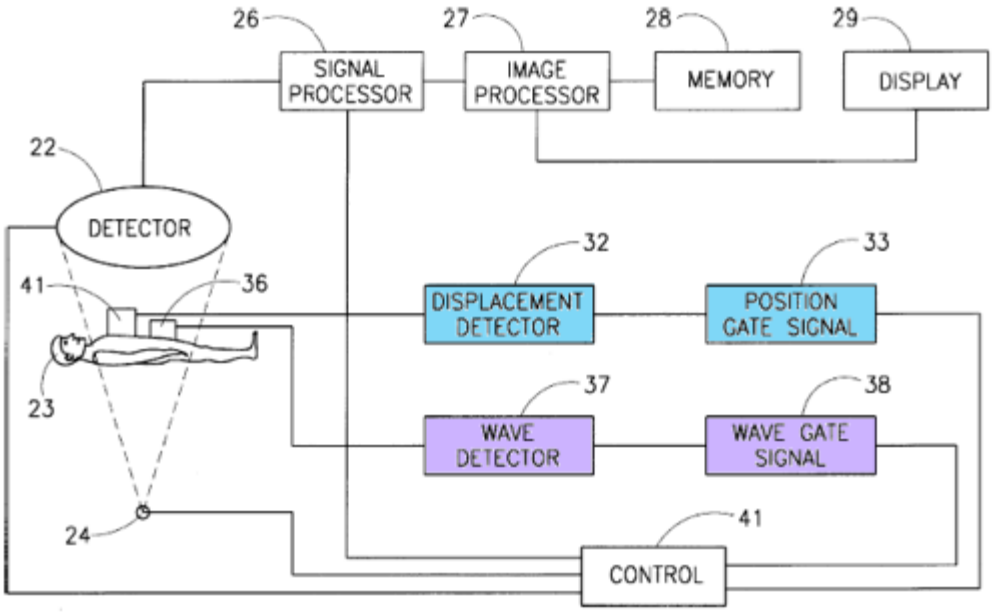


FIG.6

Wainer, Fig. 6 (annotated)

[404] In the combination, sensor 36 and **wave detector** is a "second sensor system" that obtains "second measurements" (heart beats) for PET gating when collecting PET projections. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. .

[405] The combination thus renders obvious "while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system," as recited in [1c-ii].

8. [1c-iii] the second sensor system being independent from the second imaging technique

[406] In my opinion, Weese in view of Wainer renders obvious "the second sensor system being independent from the second imaging technique" as recited in [1c-iii].

[407] As discussed for Ground 1, Weese discloses "the second sensor system being independent from the second imaging technique," as recited in [1c-iii]; § XII.B.8 ([1c-iii]). In the Weese-Wainer combination, sensor 36 and **wave detector 37** is a "second sensor system." Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; § XIV.B.8 ([1c-ii]). Sensor 36 and **wave detector** are independent from PET acquisition ("second imaging technique") because they monitor the cardiac cycle, not emissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6.

[408] The combination thus renders obvious "the second sensor system being independent from the second imaging technique," as recited in [1c-iii].

9. [1d] associating the plurality of second images with second movement states of the mobile object using the first [sic] measurements; and

[409] In my opinion, Weese in view of Wainer renders obvious "associating the plurality of second images with second movement states of the mobile object using the first [sic] measurements" as recited in [1d]. Here, I use "[sic]" to point out

that the claim requires using the ***first*** measurements, not the second measurements, when associating second images with second movement states. [2]

[410] The Weese-Wainer combination implements Wainer's teaching to use position sensor 31 with **displacement detector 32** for respiratory gating and sensor 36 with **wave detector 37** for cardiac gating. Wainer, 8:40-9:20, Fig. 6; § XIV.A (Ground 3 Overview: Weese in view of Wainer).

[2] To the extent Patent Owner argues "first" is a typographical error and the claim should recite "second measurements," my analysis of limitation [12d] demonstrates that Weese in view of Wainer renders obvious "associating the plurality of second images with second movement states of the mobile object using the second measurements." § XIV.M.9 ([12d]).

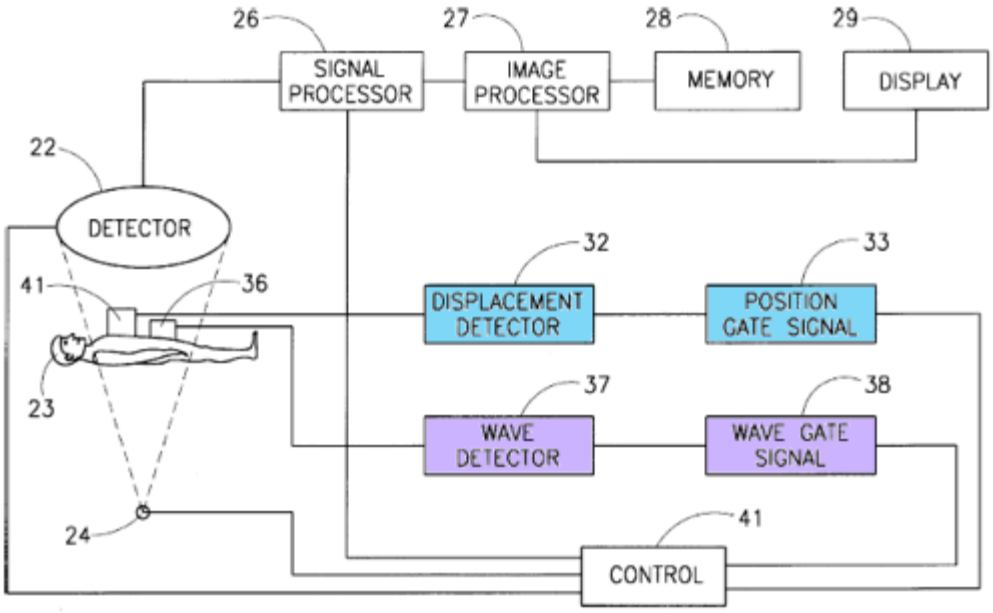


FIG.6

Wainer, Fig. 6 (annotated)

[411] Above, I explained that measurements from position sensor 31 and **displacement detector 32** are "first measurements" of limitation [1a-ii]. § XII.B.2-4 (Ground 3, [1a-i]-[1a-iii]). When gating for both respiratory and cardiac motion, the combination windows or "bins" projections by both the phase of the breathing cycle and the phase of the cardiac cycle before reconstructing images. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. For example, the combination bins projections for a "full inhalation" phase of the breathing cycle into different phases of a cardiac cycle. Windowing or binning projections was a long-known technique, and a POSITA would have had success when implementing this approach in the combined Weese-Wainer system. *E.g.*, Ex-1008 (Bushberg textbook), 453, 696-699; Ex-1011, 367

(binning PET projections for respiration); Ex-1012 (same); Ex-1014, 1920-21 (same).

[412] Accordingly, the combination "associate[es] the plurality of second images with second movement states of the mobile object using the first [sic] measurements," as recited in [1d], when gating Weese's PET images for both cardiac and respiratory motion by windowing or binning PET images into phases of the respiratory cycle.

10. [1e] forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states,

[413] In my opinion, Weese in view of Wainer renders obvious "forming an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement measurements, and said second movement states," as recited in [1e].

[414] I identify two ways in which the combination renders this limitation obvious, discussed below: (a) a volume image formed from a plurality of fused dual-gated PET and CT slice images, and (b) a fused image formed from multiple dual-gated PET images and dual-gated CT image at different phases of a breathing cycle.

[415] First, I will show fused slice images formed from dual gated PET and CT slice images would have been obvious. The Weese-Wainer combination implements respiratory gating (first measurements and first movement states) and cardiac gating (second measurements and second movement states) of CT images (first images) and PET images (second images). §§ § XIV.A (Ground 3 Overview: Weese in view of Wainer), XIV.B.2-4 ([1a-i]-[1a-iii]), XIV.B.6-8 ([1c-i]-[1c-iii]). That is, the combination creates dual gated PET and CT slice images.

[416] A POSITA would have found it obvious to fuse (e.g., superimpose) dual-gated PET and CT images and would have had a reasonable chance of success when doing so. Both references teach to superimpose structural and functional images. Weese, ¶¶ [0076], [0085], Figs. 1-3 (e.g., I7, I8, I9); Wainer 7:32-41, Figs 4a, 4b, claims 1, 6-7. Weese discloses that its PET and CT images are already registered and ready to combine when using a combination PET/CT apparatus. Weese, ¶ [0072], Figs. 1-3, 6. Further, Wainer discloses its gated structural and functional images may be "automatically" combined when implementing gating because this registers the images to the same motion state and removes artifacts. Wainer, 3:56-60, 6:5-52. Weese likewise teaches the benefits of combining PET and CT at the same motion state. Weese, ¶¶ [0076]-[0077], [0079]-[0080], [0083], Figs. 1-3. In view of these teachings, a POSTIA would have been motivated to combine dual-gated functional PET images and structural CT images to enhance the

quality of information and provide additional insights into the location of tissues of interest.

[417] I note that limitation [1e] requires forming "***an*** image based on said ***plurality*** of first images . . . and on said ***plurality*** of second images," but an image formed from a dual gated PET and a dual gated CT image is based on only one "first image" and one "second image." However, Weese-Wainer still renders this requirement obvious in two ways: (a) a volume image formed from a plurality of fused dual-gated PET and CT slice images is "***an*** image based on said ***plurality*** of first images . . . and on said ***plurality*** of second images," and (b) a fused image formed from dual-gated PET images and dual-gated CT image at different time points is likewise "***an*** image based on said ***plurality*** of first images . . . and on said ***plurality*** of second images."

a. Weese-Wainer renders obvious fused dual-gated PET and CT volume images, which renders obvious [1e]

[418] The Weese-Wainer combination renders obvious fused dual-gated PET and CT volume images, which renders obvious [1e]. Both references disclose creating 3D volume images, and it would have been obvious to use a plurality of dual-gated fused PET and CT images to render a fused volume image.

[419] Weese teaches its PET and CT images may be "volume images" and states volume images may be made according to "known" techniques without

specifying any particular way to do so. Weese, ¶¶ [0002], [0026], [0048], [0058], [0061]; § XII.B.6.a (Ground 1, [1c-i]).

[420] Wainer discloses creating functional volume images, and it provides an exemplary method: stacking 2D slices to render 3D images. Wainer, 6:53-7:32. Wainer explains "[t]ypically a three dimensional image is acquired and processed as a series of two dimensional slices." Wainer, 6:53-55. Such slice-by-slice volume rendering was long known. Muehllehner, Abstract ("slice-by-slice" PET approach), 1:65-2:14 (same), 12:48-60 (same), 13:18-38 (claim 1), Figs. 2, 2a, 11-13; Ex-1019, Abstract, 2:18-33, 5:61-6:4, 6:11-25, 10:60-62, 16:62-67, Fig. 2; Ex-1020, ¶ [0081]; Ex-1008 (Bushberg textbook), 360-362; § VII (TECHNOLOGICAL BACKGROUND). And Wainer further motivates making 3D volume images by providing one advantage, noting that "the attending doctor will not have to work directly with image slices" when reviewing images. Wainer, 7:26-31.

[421] A POSITA would have found it straightforward and obvious to rely on Weese's and Wainer's teachings to create volume images based on the combination's fused PET and CT slice images. When doing so, the combination "form[s] an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement measurements, and said second movement states," as recited in [1e].

b. Weese-Wainer renders obvious fusing dual-gated PET images and dual-gated CT images at different time points, which renders obvious [1e]

[422] Weese-Wainer renders obvious superimposing dual-gated PET images and dual-gated CT images at different time points, which renders obvious [1e].

[423] As I explained above for this limitation, both references teach to superimpose structural and functional images, and it would have been obvious to superimpose dual-gated CT and PET images in the Weese-Wainer combination. Weese, ¶¶ [0076], [0085], Figs. 1-3 (e.g., I7, I8, I9); Wainer 7:32-49, Figs 4a, 4b, claims 1, 6-7. Further, it would have been obvious to superimpose multiple dual-gated images at different time points because Wainer explicitly teaches doing so. Wainer, 7:32-49. This renders obvious [1e].

[424] Wainer discloses superimposing images at different time points to track changes or evolution in radiotracer distribution. Wainer, 5:3-14 (discussing time associated with areas 2, 2' and 6, 6'), 7:32-49, Fig. 4A-4B. For example, Figure 4A (below) shows superposition of functional images at different timepoints. Wainer, 4:8-11, 7:32-41, Fig. 4A. Figure 4B (below) shows superposition of a functional image and structural CT image at one timepoint. Wainer, 4:12-14, 7:33-41, Fig. 4B.

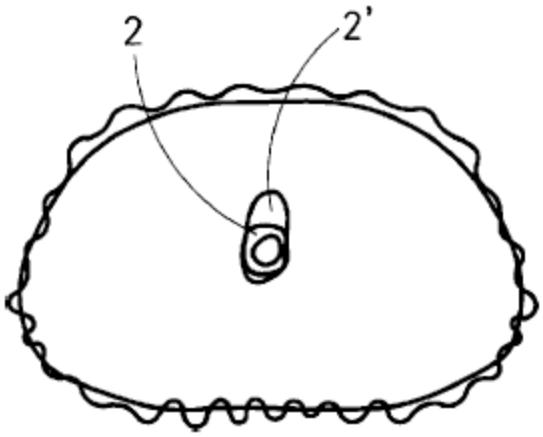


FIG.4A

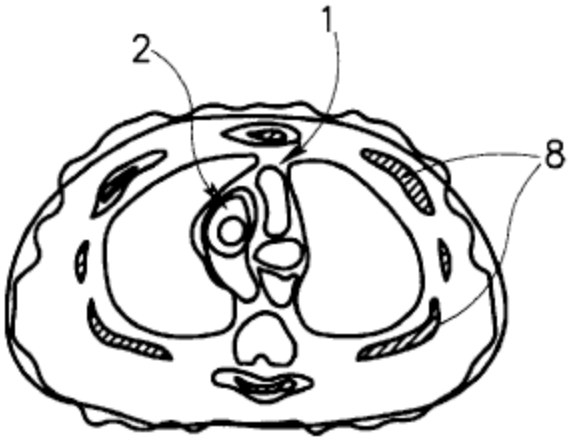


FIG.4B

Wainer, Figs. 4A-4B

[425] Wainer uses the term "processing" to describe image subtraction, superposition, outlining and coloring images, and Wainer flexibly teaches "simultaneous processing and viewing of several images at once." Wainer, 7:32-49. Over these flexible teachings, a POSITA would have found it obvious to

superimpose multiple structural and functional dual-gated images. This renders obvious [1e].

[426] In addition, Wainer teaches that structural images at different timepoints may need to be registered prior to combination owing to changes due to breathing and placement on the examination table. Wainer, 5:32-49. Wainer provides methods of registering structural images to facilitate the combination of functional images at different times to track treatment process. Wainer, 5:50-6:9. For example, Wainer teaches to register two functional images 6 and 6' taken at different time points after registration of their corresponding functional images. Wainer, 6:6-9. A superimposed dual-gated functional image based on two dual-gated functional image registered to different dual-gated structural images is "an image [formed] based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states," as recited in [1e]. Weese-Wainer renders obvious [1e] for this additional reason.

11. [1f] wherein the first imaging technique is different from the second imaging technique.

[427] In my opinion, Weese in view of Wainer renders obvious "wherein the first imaging technique is different from the second imaging technique," as recited

in [1f]. In my analysis, the first imaging technique is CT imaging, while the second imaging technique is PET imaging, which are different techniques. §§ XIV.B.2-4 ([1a-i]-[1a-iii]), XIV.B.6-8 ([1c-i]-[1c-iii]).

C. Claim 2

[2] The method of claim 1, further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states.

[428] In my opinion, Weese in view of Wainer renders obvious "[t]he method of claim 1, further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states," as recited in claim 2.

[429] Weese-Wainer time-synchronizes CT and PET images into different windows or bins based on the phase of the respiratory cycle and cardiac cycle, which involves comparing first and second movement states (respiratory and cardiac states). § XIV.A (Ground 3 Overview: Weese in view of Wainer). When gating for both respiratory and cardiac motion, the combination windows or "bins" projections by both the phase of the breathing cycle and the phase of the cardiac cycle before reconstructing images. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. For example, the combination bins projections for a "full inhalation" phase of the breathing cycle into different phases of a cardiac cycle. Windowing or binning projections was a

long-known technique, and a POSITA would have had success when implementing this approach in the combined Weese-Wainer system. *E.g.*, Ex-1008 (Bushberg textbook), 453, 696-699; Ex-1011, 367 (binning PET projections for respiration); Ex-1012 (same); Ex-1014, 1920-21 (same).

[430] Accordingly, Weese-Wainer renders obvious claim 2.

D. Claim 3

[3] The method of claim 1, further comprising: forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

[431] In my opinion, Weese in view of Wainer renders obvious "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images," as recited in claim 3.

[432] In the combination, CT images are a "plurality of first images," and these images are "reconstructed" from X-ray detection data. Weese, ¶¶ [0052]-[0057], [0062], [0072], [0078]-[0079], [0084]; §§ XIV (Ground 3 (Weese in View of Wainer)), XIV.B.2-4 ([1a-i]-[1a-iii]). Weese in view of Wainer thus renders obvious "forming first reconstructed images corresponding to said plurality of first images," as recited in claim 3.

[433] In the combination, PET images are a "plurality of second images," and Weese discloses PET images are "reconstructed" from projections P1. Weese,

¶¶ [0047]-[0051], [0058], [0070]-[0072], [0078]-[0079], [0084]; §§ XIV (Ground 3 (Weese in View of Wainer)), XIV.B.6-8 ([1c-i]-[1c-iii]). Weese in view of Wainer thus renders obvious "forming . . . second reconstructed images corresponding to said plurality of second images," as recited in claim 3.

E. Claim 4

[4] The method of claim 3, further comprising: spatially-synchronizing said first reconstructed images and said second reconstructed images.

[434] In my opinion, Weese in view of Wainer renders obvious "[t]he method of claim 3, further comprising: spatially-synchronizing said first reconstructed images and said second reconstructed images," as recited in claim 4.

[435] Image registration is spatial synchronization. The '353 patent describes "spatial synchronization" as a process that registers two images, consistent with well-known methods. Ex-1001, 3:54-61; *see* Weese, ¶¶ [0073]-[0074] (describing registration); Ex-1009 (same); Ex-1011, ¶¶ [0011], [0013]-[0014], [0033]. Indeed, the patent specifically states this process "is not innovative" and the alleged "invention is not applicable to it." Ex-1001, 3:54-61.

[436] Both teach the importance of registration prior to fusing or superimposing structural and functional images. Weese, ¶¶ [0072]-[0075]; Wainer, 3:51-60, 5:50-6:9, 7:32-49, 8:38-59. In the combination, PET and CT images are

dual gated. §§ XIV.A (Ground 3 Overview: Weese in view of Wainer), XIV.B (Claim 1).

[437] Wainer discloses registering gated images prior to combining structural and functional images. Wainer, 3:33-60, 4:56-61, 5:50-6:9, 7:32-49, 8:38-9:20. For example, Wainer states image processing like superposition may occur "[o]nce the transformation between two images are known," referring to registration. Wainer, 7:32-33. Wainer teaches that structural images at different timepoints during a treatment regime may need to be registered prior to combination owing to changes due to breathing and placement on the examination table. Wainer, 5:32-49. Wainer provides methods of registering structural images to facilitate the combination of functional images at different times to track treatment process. Wainer, 5:50-6:9.

[438] Weese likewise discloses registration prior to combination. Weese, ¶¶ [0072]-[0075]. Weese teaches such registration was generally known at the time. Weese, ¶ [0073]. Weese registers PET and CT images to facilitate comparison or combination. Weese, ¶ [0075].

[439] Accordingly, it would have been obvious to superimpose dual-gated PET and CT images of Weese-Wainer. § XIV.B.10 ([1e]). Further, it would have been obvious in the Weese-Wainer combination to register dual-gated PET and CT images prior to creating superimposed images, which renders obvious claim 4.

F. Claim 5

[5] The method of claim 1, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

[440] In my opinion, Weese in view of Wainer renders obvious "[t]he method of claim 1, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique," as recited in claim 5.

[441] In the combination, CT images are a "plurality of first images," CT is a "radiation attenuation technique." Weese, ¶¶ [0052]-[0057], [0062], [0072], [0078]-[0079], [0084]; §§ XIV (Ground 3 (Weese in View of Wainer)), XIV.B.2-4 ([1a-i]-[1a-iii]). Weese in view of Wainer thus renders obvious "said first imaging technique is a radiation attenuation technique," as recited in claim 5.

[442] In the combination, PET images are a "plurality of second images," and PET is "radiation emission technique." Weese, ¶¶ [0047]-[0051], [0058], [0070]-[0072], [0078]-[0079], [0084]; §§ XIV (Ground 3 (Weese in View of Wainer)), XIV.B.6-8 ([1c-i]-[1c-iii]). Weese in view of Wainer thus renders obvious "said second imaging technique is a radiation emission technique," as recited in claim 5.

G. Claim 6

[6] The method of claim 1, further comprising: spatially-synchronizing the plurality of first images and the plurality of

second images using said plurality of first measurements and said plurality of second measurements.

[443] In my opinion, Weese in view of Wainer renders obvious "[t]he method of claim 1, further comprising: spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements," as recited in claim 6.

[444] Weese-Wainer renders obvious registering dual-gated images. § XIV.E (claim 4). Dual-gated images are formed using "first measurements" and "second measurements" from respiratory and cardiac sensor systems. §§ XIV.B.2-4 ([1a-i]-[1a-iii])- XIV.B.6-8 ([1c-i]-[1c-iii]). Further, image registration is spatial-synchronization. § XIV.E (claim 4). Accordingly, by registering dual-gated PET and CT images prior to combining images, Weese-Wainer renders obvious "spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements," as recited in claim 6.

H. Claim 7

[7] The method of claim 1, further comprising: forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

[445] In my opinion, Weese in view of Wainer renders obvious "forming displacement fields corresponding, respectively, to said plurality of first images, said

plurality of first measurements, said plurality of second images, and said plurality of second measurements," as recited in claim 7. Weese in view of Wainer renders this limitation obvious in two ways.

1. Weese-Wainer's registration renders obvious [1e]

[446] First, the registration process of Weese-Wainer renders obvious claim 7. §§ XIV.E (claim 4), XIV.G (claim 6). This registration teaches each feature of claim 7:

- Weese-Wainer's registration involves mathematical transformations of an image, i.e., "displacement fields." Weese discloses mathematical "coordinate transformation," including non-rigid transformation of Ex-1009. Weese, ¶¶ [0073]-[0074]; Ex-1009, 1610-11 (defining mathematical "transformation operator" through translation, rotation, and deformations). Wainer similarly discloses mathematical approaches to map features of different images to one another. Wainer, 7:50-8:37 ("landmark matching, surface matching, spatial parameters matching, invariant geodesic lines and point matching.").
- Weese-Wainer's registration "correspond[s] to "first measurements" and "second measurements" from respiratory and cardiac gating sensor data, as required in claim 7, because registration is based on dual-gated images. §§ XIV.E (claim 4), XIV.G (claim 6).

- Weese-Wainer's registration "correspond[s]" to "first images" and "second images," as required in claim 7. Weese and Wainer both teach registration can be applied to structural or functional images—i.e. the mathematical operators ("displacement fields") correspond to CT and PET images. *E.g.*, Weese, ¶ [0075] (registering PET to CT images or vice versa); Wainer, 5:50-6:9 (registering structural images and registering functional images), 7:50-8:37.

2. The motion model of Weese-Wainer renders obvious claim 7.

[447] As I explained above for Ground 1, Weese's motion vector fields of motion model M2 discloses and renders obvious the "displacement fields" of claim 7. Weese, ¶¶ [0063]-[0067]; § XII.H (Ground 1, claim 7). As I will explain, it would have been obvious in the Weese-Wainer combination to construct and use these same motion vector fields. Accordingly, Weese in view of Wainer renders obvious claim 7.

[448] Weese discloses using "motion model M2" to "focus" images that are blurred by motion artifacts. Weese, ¶¶ [0077], [0080] ("focusing B1 of the image I5 by means of the motion model M2.") Fig. 1 (step B1, de-blurring I6 to form I7), Fig. 2 (de-blurring I0 to form I8). Weese teaches that making images sharper is desirable because it enhances the precision and quality of information. Weese, ¶¶ Abstract, [0004], [0018], [0022], [0028]-[0029], [0034]-[0035], [0052], [0083].

Wainer likewise describes the goal of reducing motion artifacts or object "smearing" and uses gating to achieve that goal. Wainer, 3:33-60, 4:56-61, 8:38-49.

[449] While Weese-Wainer's dual-gating reduces motion artifacts, some motion artifacts still remain because gated images are windowed or binned into *phases* for reconstruction. Wainer, 3:33-60, 4:56-61, 8:38-49; § XIV.A (Ground 3 Overview: Weese in view of Wainer). A *phase* is not an *instant*—it is a time period during which motion occurs occur within a breathing or cardiac cycle, albeit a shorter time period than an entire cycle. The number and duration of time bins determines how much blurring occurs. The Bushberg textbook illustrates this principle for nuclear medicine, e.g., PET, showing gated images acquired over the duration of a phase, teaching that while four bins are shown sixteen or even twenty four may be used in practice. Ex-1008, 698. More bins would, of course, lead to fewer motion artifacts.

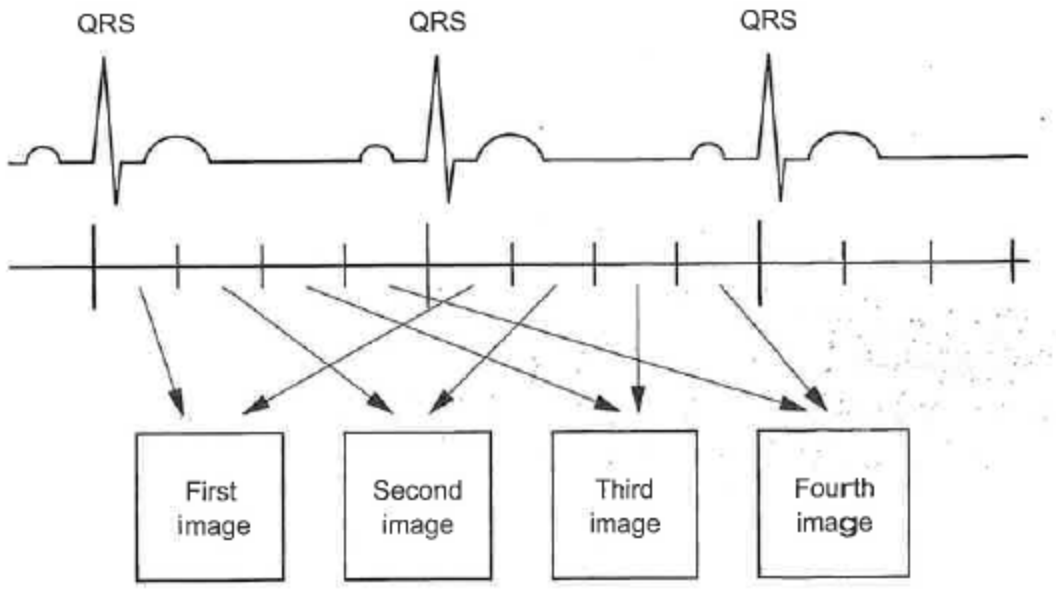


FIGURE 21-22. Acquisition of a gated cardiac image sequence. Only four images are shown here. Sixteen to 24 images are typically acquired.

Ex-1008, 698 (Figure 21-22)

[450] For PET images, gating presents a tradeoff between accuracy and longer acquisition times needed to obtain sufficient projection data for reconstruction. Ex-1011, 368 (longer gated scan than non-gated scan); Ex-1016, 589 (noting disadvantages of longer acquisition times in gated PET); Ex-1021, 352 (same); *see* Ex-1008, 453 (noting tradeoff of longer acquisition times for gated MRI images). Due to these practical considerations, a POSITA seeking to obtain higher accuracy as compared to ungated PET images may have used PET gating with fewer bins than CT gating in the Weese-Wainer combination, i.e., with fewer phases gated per cycle. This improves accuracy over ungated PET images because gated PET leads to fewer motion artifacts, and it avoids overly long PET acquisition times by

keeping the number of bins sufficiently small. *See* Ex-1008, 698; Ex-1011, 368; Ex-1016, 589; Ex-1021, 352. As a result, while gated PET images would be sharper than ungated PET images and have fewer motion artifacts, gated PET images may have still had motion artifacts due to blurring within a phase. And these images would have represented phases that were longer than the corresponding CT images, which would be more finely gated.

[451] Weese provides a solution to the problem of blurred PET images representing longer phases than finely-gated CT images: sharpening "by means of the motion model M2." Weese, ¶¶ [0077], [0080], Figs. 1-2. A POSITA would been motivated to focus gated PET images with Weese's motion vector fields to achieve the precision and quality of information Weese and Wainer seek. Weese, ¶¶ Abstract, [0004], [0018], [0022], [0028]-[0029], [0034]-[0035], [0052], [0083]; Wainer, 3:33-60, 4:56-61, 8:38-49.

[452] A POSITA would have been successful when implementing Weese's motion vectors in the combination. The motion vectors are constructed based on CT images at a particular motion state (I2, I3) and sensor data from Weese's sensor S1 that measures the "actual motion" during PET acquisition. Weese, ¶¶ [0063]-[0067]; § XII.B (Ground 1, claim 1). These same features are present in the Weese-Wainer combination. § XIV.A (Ground 3 Overview: Weese in view of Wainer). The combination would have generated CT images corresponding to opposites in a

motion cycle (e.g., full inhalation and exhalation) while collecting measurements corresponding to the body rhythm (e.g., breathing).

[453] Further, Weese and Wainer both describe combining images that represent the same motion state. § XIV.B.10 (Ground 3, [1e]). Wainer discloses its gated structural and functional images may be "automatically" combined when implementing gating because this registers the images to the same motion state and removes artifacts. Wainer, 3:56-60, 6:5-52. Weese likewise teaches the benefits of combining PET and CT at the same motion state. Weese, ¶¶ [0076]-[0077], [0079]-[0080], [0083], Figs. 1-3. It would have been obvious to construct and use Weese's motion vector fields of motion model M2 to focus gated PET images prior to combining with gated CT images because PET images may be gated into fewer bins of longer duration than CT images. This would allow combination of PET and CT at the same motion state.

[454] Accordingly, for the same reasons discussed for Ground 1, constructing and using motion fields of motion model M2 renders claim 7 obvious for the Weese-Wainer combination. § XII.H (Ground 1, claim 7).

I. Claim 8

[8] The method of claim 7, wherein said forming an image of the mobile object comprises combining said displacement fields.

[455] In my opinion, Weese in view of Wainer renders obvious "[t]he method of claim 7, wherein said forming an image of the mobile object comprises combining said displacement fields," as recited in claim 8. § XII.H (Ground 1, claim 7).

[456] As discussed for claim 7, it would have been obvious to use Weese's motion vector fields of motion model M2 to focus gated PET images prior to combining with gated CT images because PET images may be gated into fewer bins of longer duration. § XIV.H (claim 7). Using Weese's motion vector fields comprises "combining" these fields because it accounts for displacement from one phase to the next. *See* Ex-1001, 7:24-29; § XII.I (Ground 1, claim 8, explaining how use of motion model discloses combining displacement fields). Accordingly, Weese in view of Wainer renders obvious claim 8.

J. Claim 9

[9] The method of claim 7, wherein said forming displacement fields comprises:
estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields.

[457] In my opinion, Weese in view of Wainer renders obvious "[t]he method of claim 7, wherein said forming displacement fields comprises: estimating movement of the mobile object based, respectively, on said plurality of first images,

said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields," as recited in claim 9.

[458] As explained in reference to claim 7, Weese's **M2** motion vector fields are displacement fields. Weese, ¶¶ [0063]-[0068]; §§ XII.H (Ground 1, claim 7), XIV.H (Ground 3, claim 7).

[459] Also as explained, Weese discloses these fields are based on a movement estimate between "first images" **I2** and **I3**, which are extracted from sequence **IS** using "first measurements" from **motion sensor 15**. § XII.H (claim 7). Weese, ¶¶ [0031], [0057], [0063]-[0068], [0072]-[0074], [0078]-[0080]; §§ X.A (Overview of Weese (U.S. 2005/0226527)), XII.A (Ground 1 Overview: Weese), XII.B.3 ([1a-ii]), XII.H (claim 7). In the Weese-Wainer combination, the **displacement detector** is a "first sensor system" that obtains "first measurements" (position measurements) for CT gating when collecting CT transmissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §§ XIV.A (Ground 3 Overview: Weese in view of Wainer), XIV.B.2-4 ([1a-i]-[1a-iii]). In the combination, motion vectors are based on dual-gated CT images and estimate object movement. §§ XIV.H (Ground 3, claim 7). Weese-Wainer accordingly discloses and renders obvious "estimating movement of the mobile object based, respectively, on said plurality of

first images, . . . , [and] said plurality of first measurements . . . , in order to form said displacement fields," as recited in claim 9.

[460] Further, Weese's estimated movement of the motion vector fields are partially derived from "second measurements" from sensor **S1** collected while capturing projections **P1** of "second images" **I0**. Weese, ¶¶ [0065]-[0067]; §§ XII.B.7 ([1c-ii])), XII.B.10 ([1e]). In the Weese-Wainer combination, sensor 36 and **wave detector** is a "second sensor system" that plays the role of sensor **S1** and obtains "second measurements" Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §§ XIV.A (Ground 3 Overview: Weese in view of Wainer), XIV.B.6-8 ([1c-i]-[1c-iii]). Motion vectors estimate object movement. §§ XIV.H (Ground 3, claim 7). Weese-Wainer accordingly discloses and renders obvious "estimating movement of the mobile object based, respectively, on . . . said plurality of second images, . . . and said plurality of second measurements, in order to form said displacement fields," as recited in claim 9.

K. Claim 10

[10] The method of claim 9, wherein at least one of said movement estimates is formed relative to a reference time.

[461] In my opinion, Weese in view of Wainer renders obvious "[t]he method of claim 9, wherein at least one of said movement estimates is formed relative to a reference time," as recited in claim 10.

[462] Weese discloses obtaining the "actual motion" data from sensor **S1** to generate the state of motion function F1 used in motion estimates when forming its motion vectors. Weese, ¶¶ [0065]-[0067]. The same holds in the Weese-Wainer combination. §§ XIV.H (Ground 3, claim 7). The state of motion function F1 employs a "reference time." Weese, ¶¶ [0065]-[0067], Figs. 4-5. For example, Weese's motion vectors are calculated relative to the parameter *r*, which is the state of motion derived from **S1**, and Weese expresses motion vector fields as a function of r, noting that the motion oscillates between r=0 and r=1, corresponding to "inhaled state" and "exhaled state" when tracking breathing, which are both "reference times," as recited in claim 10. Weese, ¶¶ [0065]-[0067]. Weese-Wainer accordingly renders obvious claim 10.

L. Claim 11

[11] The method of claim 1, wherein the first sensor system is different from the second sensor system.

[463] In my opinion, Weese in view of Wainer renders obvious "[t]he method of claim 1, wherein the first sensor system is different from the second sensor system," as recited in claim 11.

[464] The Weese-Wainer combination uses different first and second sensor systems: position sensor 31 and **displacement detector 32** for respiratory gating and a sensor 36 and **wave detector 37** for cardiac gating. Wainer, 9:6-20, Fig. 6; §

§§ XIV.A (Ground 3 Overview: Weese in view of Wainer), XIV.B.2-4 ([1a-i]-[1a-iii]), XIV.B.6-8 ([1c-i]-[1c-iii]). Weese-Wainer thus renders obvious claim 11.

M. Claim 12

1. [12p] An apparatus to form an image of a mobile object, comprising:

[465] Weese-Wainer renders obvious [12p], as discussed for [1p]. § XIV.B.1 ([1p]).

2. [12a-i] means for obtaining a plurality of first images of the mobile object using a first imaging technique;

[466] Weese-Wainer renders obvious [12a-i], as discussed for [1a-i]. § XIV.B.2 ([1a-i]).

[467] Limitation [12a-i] would have been construed as a means-plus-function term and has the function "obtaining a plurality of first images of the mobile object using a first imaging technique." § IX.A.1 ([12a-i], claim construction). Weese-Wainer performs this function, as discussed for [1a-i]. § XIV.B.2 ([1a-i]).

[468] The corresponding structure of this term includes an attenuation or emission radiation source and detector, gantry, processor, and memory. § IX.A.1 ([12a-i], claim construction). Weese discloses CT detectors (e.g., "detector unit 16") in the context of a combination PET-CT system. Weese, ¶¶ [0053]-[0057], [0059]-[0061], Fig. 6. Weese also discloses other structures that also facilitate the function of obtaining first images, including a radiation source, gantry, computer, a

reconstruction unit 10 for reconstructing images from projections, a control unit 7, and a data processing unit 23. *Id.* Weese teaches that these structures, including the detectors, would be present in a combined CT/PET apparatus and in a separated CT system. Weese, ¶¶ [0053], [0072]. Weese's system was conventional. § VII (TECHNOLOGICAL BACKGROUND).

[469] The combination implements those structures, so a POSITA would have understood Weese-Wainer renders obvious a detector and radiation source that perform "obtaining a plurality of first images of the mobile object using a first imaging technique," as discussed for [1a-i]. §§ XIV.A (Ground 3 Overview: Weese in view of Wainer), XIV.B.2 ([1a-i]).

3. [12a-ii] means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images,

[470] Weese-Wainer renders obvious [12a-ii], as discussed for [1a-ii]. § XIV.B.3 ([1a-ii]).

[471] Limitation [12a-ii] would have been construed as a means-plus-function term and has the function "obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images." § IX.A.2 ([12a-ii], claim construction). Weese-Wainer performs this function, as discussed for [1a-ii]. § XIV.B.3 ([1a-ii]).

[472] The corresponding structure of this term includes a breathing, pressure, or electrocardiogram sensor. § IX.A.2 ([12a-ii], claim construction). In the Weese-Wainer combination, position sensor 31 is a sensor that performs the function of [12a-ii], "obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images," as discussed for [1a-ii]. § XIV.B.3 ([1a-ii]).

4. [12a-iii] the means for obtaining the plurality of first measurements being independent from the first imaging technique;

[473] Weese-Wainer renders obvious [12a-iii], as discussed for [1a-iii]. § XIV.B.4 ([1a-iii]).

5. [12b] means for associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

[474] Weese-Wainer renders obvious [12b], as discussed for [1b]. § XIV.B.5 ([1b]).

[475] The term "means for associating the plurality of first images with first movement states of the mobile object," as recited in limitation [12b], would have been construed as a means-plus-function term and has the function "associating the plurality of first images with first movement states of the mobile object." § IX.A.3

([12b], claim construction). Weese-Wainer performs this function, as discussed for [1b]. § XIV.B.5 ([1b]).

[476] I have been asked to assume the corresponding structure includes a computer programmed to perform the associating. § IX.A.3 ([12b], claim construction). Weese and Wainer each discloses it. Weese's methods are carried out on computers. Weese, Abstract ("computer program", ¶¶ [0001] (same), [0038] (same). Weese discloses an "image processing system" that is capable of receiving and processing image data. Weese, ¶ [0036]. Weese also discloses a "data processing unit" that runs a computer program, such as one on a portable storage medium. Weese, ¶¶ [0038], [0060], claim 10. Weese explains "[t]he data processing unit 23 is arranged to combine, using the method in accordance with the invention as well as the motion signal, the information contents of the CT images and the PET images, to reduce motion artifacts, if any, and to visualize the results accordingly by means of a display apparatus 11." Weese, ¶ [0060]. Weese also discloses "[a] computer readable medium containing instructions for controlling a data processing unit in such a manner that the data processing unit can carry out a method as claimed in claim 1." Weese, claim 12. Wainer likewise discloses computer processors and memory to perform its methods. Wainer, 6:65-67, 7:26-31, 7:41-49, 9:1-20 (image processor 27, with processors and memory).

[477] Accordingly, a POSITA would have understood Weese-Wainer renders obvious a computer programmed to perform "associating the plurality of first images with first movement states of the mobile object," as discussed for [1b]. § XIV.B.5 ([1b]).

6. [12c-i] means for obtaining a plurality of second images of the mobile object using a second imaging technique;

[478] Weese-Wainer renders obvious [12c-i], as discussed for [1c-i]. § XIV.B.6 ([1c-i]).

[479] Limitation [12c-i] would have been construed as a means-plus-function term and has the function "obtaining a plurality of second images of the mobile object using a second imaging technique." § IX.A.4 ([12c-i], claim construction). Weese-Wainer performs this function, as discussed for [1c-i]. § XIV.B.6 ([1c-i]).

[480] The corresponding structure of this term includes an attenuation or emission radiation source and detector, gantry, processor, and memory. § IX.A.4 ([12c-i], claim construction). Weese discloses PET detectors (e.g., "PET acquisition unit 20") in the context of a combination PET-CT system. Weese, ¶¶ [0047]-[0061], Fig. 6. Weese discloses other structures that also facilitate the function of obtaining first images, including a radiation source, gantry, computer, an evaluation unit 22 for reconstructing images from projections, a control unit 7, and a data processing unit 23. Weese, ¶¶ [0047]-[0051], [0058], Fig. 6. Weese teaches that these

structures, including the detectors, would be present in a combined CT/PET apparatus and in a separated PET system. Weese, ¶¶ [0053], [0072]; § XII.B.6 ([1c-i]). Weese's system was conventional. § VII (TECHNOLOGICAL BACKGROUND).

[481] The combination implements those structures, so a POSITA would have understood Weese-Wainer renders obvious an attenuation or emission radiation source and detector, gantry, processor, and memory that perform "obtaining a plurality of second images of the mobile object using a second imaging technique," as discussed for [1c-i]. §§ XIV.A (Ground 3 Overview: Weese in view of Wainer), XII.B.6 ([1c-i]).

7. [12c-ii] means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images,

[482] Weese-Wainer renders obvious [12c-ii], as discussed for [1c-ii]. § XIV.B.7 ([1c-ii]).

[483] Limitation [12c-ii] would have been construed as a means-plus-function term and has the function "obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images." § IX.A.5 ([12c-ii], claim construction). Weese-Wainer performs this function, as discussed for [1c-ii]. § XIV.B.7 ([1c-ii]).

[484] The corresponding structure of this term includes a breathing, pressure, or electrocardiogram sensor. § IX.A.5 ([12c-ii], claim construction). In the Weese-Wainer combination, cardiac sensor 36 is an electrocardiogram sensor that performs "obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images," as discussed for [1c-ii]. § XIV.B.7 ([1c-ii]).

8. [12c-iii] the means for obtaining the plurality of second measurements being independent from the second imaging technique;

[485] Weese-Wainer renders obvious discloses [12c-iii], as discussed for [1c-iii]. § XIV.B.8 ([1c-iii]).

9. [12d] means for associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements; and

[486] Weese-Wainer renders obvious [12d] for reasons provided for [1d]. § XIV.B.9 ([1d]).

[487] The "means for associating the plurality of second images with second movement states of the mobile object" of [12d] would have been construed as a means-plus-function term and has the function "associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements." § IX.A.6 ([12d], claim

construction). Weese-Wainer performs this function, as discussed for [1d]. § XIV.B.9 ([1c-ii]).

[488] Limitation [12d] requires "the second movement states being determined by the ***second*** measurements," while [1d] requires "associating the plurality of second images with second movement states of the mobile object using the ***first*** measurements." But the same processes in Weese-Wainer that render obvious [1d] also disclose the function of [12d] because gating for both respiratory and cardiac motion windows "bins" projections by both the phase of the breathing cycle and the phase of the cardiac cycle. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; § XIV.B.9 ([1d]).

[489] I have been asked to assume the structure corresponding to the function "associating the plurality of second images with second movement states of the mobile object" includes a computer programmed to perform the associating. § IX.A.6 ([12d], claim construction). Weese-Wainer renders it obvious because Weese and Wainer both implement their methods on computerized systems, as discussed for [12b]. § XIV.M.5 ([12b])

[490] Accordingly, a POSITA would have understood Weese-Wainer renders obvious a computer programmed to perform "associating the plurality of first images with first movement states of the mobile object," as discussed for [1d]. § XIV.B.9 ([1d]).

10. [12e] means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,

[491] Weese-Wainer renders obvious [12e], as discussed for [1e]. § XIV.B.10 ([1e]).

[492] Limitation [12e] would have been construed as a means-plus-function term and has the function "forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states." § IX.A.7 ([12e], claim construction). Weese-Wainer performs this function, as discussed for [1e]. § XIV.B.10 ([1e]).

[493] I have been asked to assume the corresponding structure includes a computer programmed to perform the forming. § IX.A.7 ([12e], claim construction). Weese-Wainer renders it obvious. Weese-Wainer renders it obvious because Weese and Wainer both implement their methods on computerized systems, as discussed for [12b]. § XIV.M.5 ([12b])

[494] Accordingly, a POSITA would have understood Weese-Wainer renders obvious a computer programmed to perform "forming an image of the mobile object based on said plurality of first images, said associated plurality of first

measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states," as discussed for [1e]. § XIV.B.10 ([1e]).

11. [12f] wherein the first imaging technique is different from the second imaging technique.

[495] Weese-Wainer renders obvious [12f], as discussed for [1f]. § XIV.B.11 ([1f]).

N. Claim 13 [13] The apparatus of claim 12, further comprising: means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

[496] Weese-Wainer renders obvious claim 13, as discussed for claim 3. § XIV.D (claim 3).

[497] Claim 13 would have been construed as a means-plus-function term and has the function "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images." § IX.A.8 (claim 13, claim construction). Weese-Wainer performs this function, as discussed for claim 3. § XIV.D (claim 3).

[498] I have been asked to assume the corresponding structure includes a computer programmed to perform the forming. § IX.A.8 (claim 13, claim construction). Weese discloses it. Weese-Wainer render it obvious because Weese

and Wainer both implement their methods on computerized systems, as discussed for [12b]. § XIV.M.5 ([12b])

[499] Accordingly, a POSITA would have understood Weese-Wainer renders obvious a computer programmed to perform "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images," as discussed for claim 3. § XII.D (claim 3).

O. Claim 14 [14] The apparatus of claim 12, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

[500] Weese-Wainer renders obvious claim 14, as discussed for claim 5. § XIV.F (claim 5).

P. Claim 15 [15] The apparatus of claim 12, further comprising: means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

[501] Weese-Wainer renders obvious claim 15, as discussed for claim 7. § XIV.H (claim 7).

[502] Claim 15 would have been construed as a means-plus-function term and has the function "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements." § IX.A.9 (claim 15,

claim construction). Weese-Wainer performs this function, as discussed for claim 7. § XIV.H (claim 7).

[503] I have been asked to assume the corresponding structure includes a computer programmed for forming displacement fields. § IX.A.9 (claim 15, claim construction). Weese-Wainer renders it obvious because Weese and Wainer both implement their methods on computerized systems, as discussed for [12b]. § XIV.M.5 ([12b])

[504] Accordingly, a POSITA would have understood Weese-Wainer renders obvious a computer programmed to perform "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements," as discussed for claim 7. § XIV.H (claim 7).

Q. Claim 16 [16] The apparatus of claim 15, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields.

[505] Weese-Wainer renders obvious claim 16, as discussed for claim 8. § XIV.I (claim 8).

[506] Claim 16 would have been construed as a means-plus-function term and has the function "combining said displacement fields." § IX.A.10 (claim 16, claim construction). Weese-Wainer performs this function, as discussed for claim 8. § XIV.I (claim 8).

[507] I have been asked to assume the corresponding structure includes a computer programmed for combining displacement fields. § IX.A.10 (claim 16, claim construction). Weese-Wainer renders it obvious because Weese and Wainer both implement their methods on computerized systems, as discussed for [12b]. § XIV.M.5 ([12b]).

[508] Accordingly, a POSITA would have understood Weese-Wainer renders obvious a computer programmed for "combining said displacement fields," as discussed for claim 8. § XIV.I (claim 8).

R. Claim 17 [17] The apparatus of claim 15, wherein said means for forming displacement fields comprises: means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields.

[509] Weese discloses claim 17, as discussed for claim 9. § XIV.J (claim 9).

[510] Claim 17 would have been construed as a means-plus-function term and has the function "estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields." § IX.A.11 (claim 17, claim construction). Weese-Wainer renders obvious this function, as discussed for claim 9. § XIV.J (claim 9).

[511] I have been asked to assume the corresponding structure includes a computer programmed for estimating movement based on images and measurements. § IX.A.11 (claim 17, claim construction). Weese-Wainer renders it obvious because Weese and Wainer both implement their methods on computerized systems, as discussed for [12b]. § XIV.M.5 ([12b])

[512] Accordingly, a POSITA would have understood Weese-Wainer renders obvious a computer programmed for "estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields," as discussed for claim 9. § XIV.J (claim 9).

S. Claim 18 [18] The apparatus of claim 17, wherein at least one of said movement estimates is to be formed relative to a reference time.

[513] Weese-Wainer renders obvious claim 18, as discussed for claim 10. § XIV.K (claim 10).

XV. GROUND 4 (WAINER)

A. Claim 1

[514] In my opinion, claim 1 is obvious over Wainer.

1. [1p] A method of forming an image of a mobile object, comprising:

[515] Wainer discloses [1p].

[516] Wainer discloses forming images of moving objects. For example, Wainer discloses acquiring and displaying SPECT images, SPTCT images, STET images, and CT images of patients. Wainer, Abstract, 1:10-61, 2:24-53, 8:60-9:20, Figs. 1-6. Wainer teaches combining these images in various ways. Wainer, 6:53-55, 7:32-49, Fig. 4A-4B. Wainer teaches that the patient experiences "body rhythms and motions" during image acquisition, such as due to breathing. Wainer, 3:33-60, 4:56-61, 8:38-9:20. The patient and their organs are mobile objects.

[517] Accordingly, Wainer discloses obvious [1p].

2. [1a-i] obtaining a plurality of first images of the mobile object using a first imaging technique;

[518] Wainer discloses [1a-i].

[519] For example, Wainer discloses obtaining structural images of patients, which may be SPTCT or CT images. *E.g.*, Wainer, Abstract, 2:29-3:60, Fig. 2A. Wainer obtains these images as a plurality of slices. Wainer, 4:34-55, 6:53-7:31. Wainer's structural images are the claimed "plurality of first images" and CT or SPECT are both "first imaging technique[s]," as recited in [1a-i].

[520] In addition, Wainer discloses collecting gated structural and functional images, which generates a plurality of images corresponding to different phases of a gated motion. Wainer, 3:33-60 (disclosing gating methods for "body rhythms"), 4:56-61 (same), 8:38-59 (gated CT and gated STET images), 8:60-9:20 (discussing

Fig. 6), Fig. 6; § X.C (Overview of Wainer (Ex-1005, U.S. 5,871,013)). Wainer discloses a simple approach to gating that was entirely conventional at the time—grouping projections into time bins associated with different motion states determined from sensor data and reconstructing images for each phase of a repetitive cycle (e.g., breathing or cardiac cycle). *E.g.*, Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6. Gating helps reduce motion-induced "smearing" in images and it facilitates registration of images taken with different modalities. Wainer, 3:33-60, 8:38-59. Wainer's approach is textbook gating. *E.g.*, Ex-1008, 452 (Bushberg textbook on gating for MRI), 696-698 (gating in nuclear medicine). Wainer's gated structural images (e.g., gated CT or SPTCT) also disclose "a plurality of first images," as recited in [1a-i].

[521] Accordingly, Wainer discloses [1a-i].

3. [1a-ii] while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system;

[522] Wainer discloses [1a-ii].

[523] It was known at the time of the '353 patent to use sensor systems to monitor motion during medical imaging, as I explained above. *See* § VII (TECHNOLOGICAL BACKGROUND). The '353 patent did not invent that approach.

[524] Wainer discloses "obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system," as recited in [1a-ii], while "obtaining a plurality of first images of the mobile object using a first imaging technique" as recited in [1a-i].

[525] Wainer employs sensors to perform its gating. Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6.; § XV.A.2 ([1a-i]). Wainer uses position sensor 31 and **displacement detector 32** for respiratory gating and a sensor 36 and **wave detector 37** for cardiac gating. Wainer, 9:6-20, Fig. 6. Wainer discloses simultaneously performing both cardiac and respiratory gating when collecting images. *Id.*

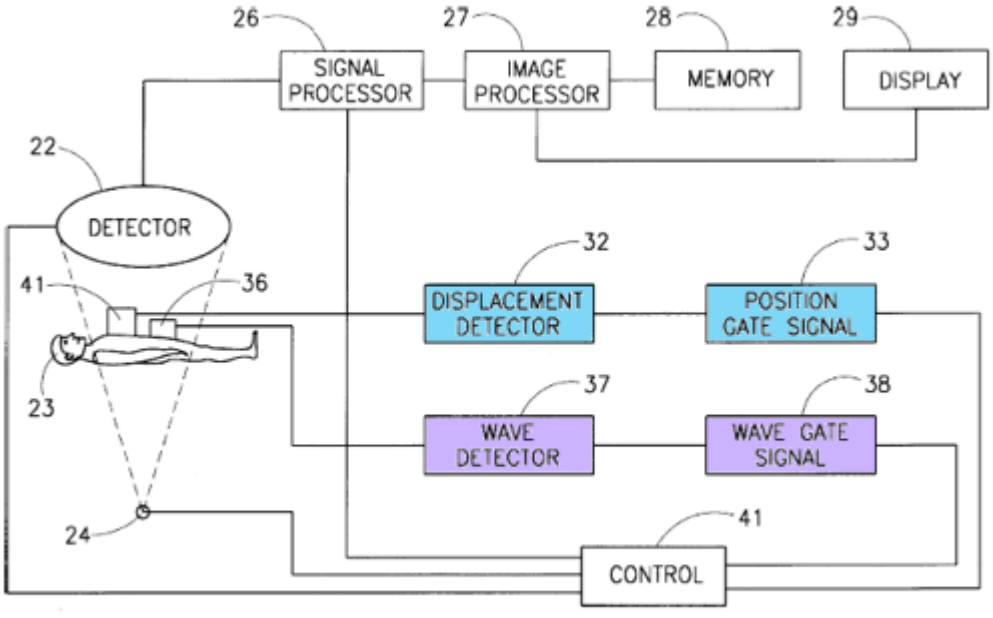


FIG.6

Wainer, Fig. 6 (annotated)

[526] Position sensor 31 and **displacement detector 32** are a "first sensor system" that obtains "first measurements" (position measurements) for structural image gating when collecting structural transmission images. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6.

[527] Accordingly, Wainer discloses [1a-ii].

4. [1a-iii] the first sensor system being independent from the first imaging technique;

[528] Wainer discloses [1a-iii].

[529] Wainer's position sensor 31 and **displacement detector 32** are a "first sensor system" that monitors position for CT gating. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. The position sensor 31 and **displacement detector 32** are simultaneous with, but independent from CT acquisition because they measure patient motion, not CT transmissions. *Id.*

[530] Accordingly, Wainer discloses [1a-iii].

5. [1b] associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

[531] Wainer discloses [1b].

[532] Wainer discloses [1b] because it gates CT images using position measurements associated with breathing. Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6.; §§ XV.A.2-XV.A.3 ([1a-i]-[1a-ii]). Wainer explains "[t]he sensed

displacement is operated on to provide windows or bins using a displacement detector 32." Wainer, 9:7-20. "In such gated images[,] data acquired during the imaging process is binned (or windowed) according to a gating signal derived from the body rhythm." Wainer, 4:56-61. These bins or windows correspond to phases of repetitive cycle (e.g., breathing), which allows for improved organ motion correction. Wainer, 3:51-60, 8:50-59. By binning or windowing CT data according to sensed displacement, Wainer discloses "associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements."

[533] Accordingly, Wainer discloses [1b].

6. [1c-i] obtaining a plurality of second images of the mobile object using a second imaging technique

[534] Wainer discloses "obtaining a plurality of second images of the mobile object using a second imaging technique," as recited in [1c-i].

[535] Wainer discloses obtaining functional images, which STET or SPECT images. *E.g.*, Wainer, Abstract, 2:29-3:60, 7:33-42, Fig. 4A; § X.C (Overview of Wainer (Ex-1005, U.S. 5,871,013). Wainer obtains these images as a plurality of 2D slices. Wainer, 4:34-55, 6:53-7:32. Wainer's functional images are the claimed "plurality of second images" and STET or SPECT is a "second imaging technique[s]," as recited in [1c-i].

[536] In addition, Wainer discloses collecting gated structural and functional images, which generates a plurality of images corresponding to different phases of a gated motion. Wainer, 3:33-60 (disclosing gating methods for "body rhythms"), 4:56-61 (same), 8:38-59 (gated CT and gated STET images), 8:60-9:20 (discussing Fig. 6), Fig. 6. Wainer discloses a simple approach to gating that was entirely conventional at the time—grouping projections into time bins associated with different motion states determined from sensor data and reconstructing images for each phase of a repetitive cycle (e.g., breathing or cardiac cycle). *E.g.*, Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6. Gating helps reduce motion-induced "smearing" in images and it facilitates registration of images taken with different modalities. Wainer, 3:33-60, 8:38-59. Wainer's approach is textbook gating. *E.g.*, Ex-1008, 452 (Bushberg textbook on gating for MRI), 696-698 (gating in nuclear medicine). Wainer's gated functional images (e.g., gated STET) also disclose "a plurality of second images," as recited in [1c-i].

[537] Accordingly, Wainer discloses [1c-i].

7. [1c-ii] while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system

[538] Wainer discloses "obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system," as

recited in [1c-ii], while "obtaining a plurality of first images of the mobile object using a first imaging technique" as recited in [1c-i].

[539] It was known at the time of the '353 patent to use sensor systems to monitor motion during medical imaging, as I explained above. *See* § VII (TECHNOLOGICAL BACKGROUND). The '353 patent did not invent that approach.

[540] Wainer employs sensors to perform its gating. Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6.; § XV.A.2 ([1a-i]). Wainer uses position sensor 31 and **displacement detector 32** for respiratory gating and a sensor 36 and **wave detector 37** for cardiac gating. Wainer, 9:6-20, Fig. 6. Wainer discloses performing both cardiac and respiratory gating when collecting images. *Id.*

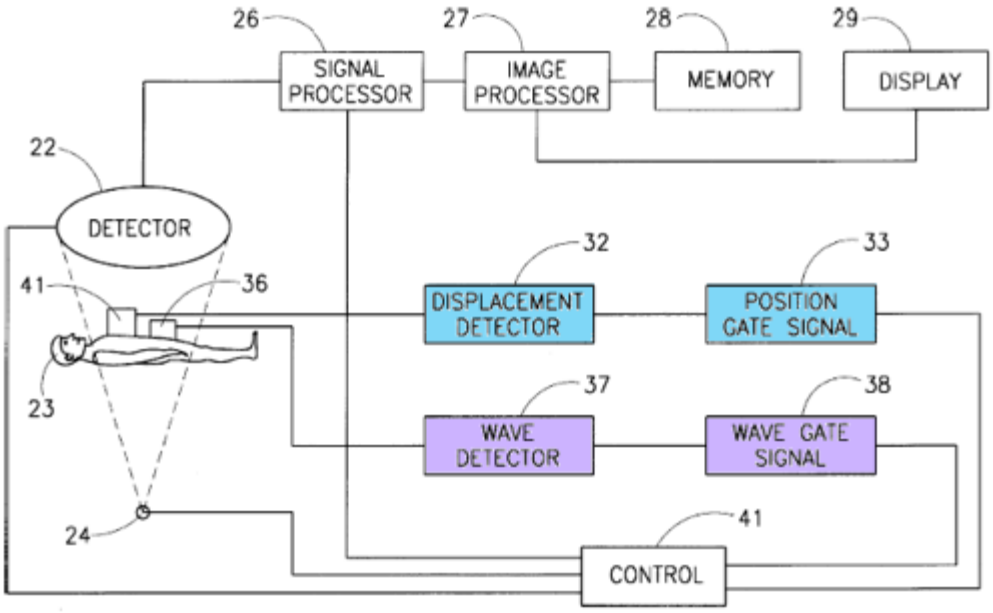


FIG.6

Wainer, Fig. 6 (annotated)

[541] Sensor 36 and **wave detector 37** are a "second sensor system" that obtains "second measurements" (heart beats) for functional image gating when collecting functional emission images. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6.

[542] Wainer thus discloses "while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system," as recited in [1c-ii].

8. [1c-iii] the second sensor system being independent from the second imaging technique

[543] Wainer discloses "the second sensor system being independent from the second imaging technique" as recited in [1c-iii].

[544] Sensor 36 and **wave detector 37** are a "second sensor system." Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. § XV.A.6 ([1c-ii]). Sensor 36 and **wave detector 37** are monitor heartrate simultaneously with, but independently from emission image. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6.

[545] Wainer thus discloses "the second sensor system being independent from the second imaging technique," as recited in [1c-iii].

9. [1d] associating the plurality of second images with second movement states of the mobile object using the first [sic] measurements; and

[546] Wainer discloses "associating the plurality of second images with second movement states of the mobile object using the first [sic] measurements" as recited in [1d]. Here, I use "[sic]" to point out that the claim requires using the ***first*** measurements, not the second measurements, when associating second images with second movement states.[3]

[3] To the extent Patent Owner argues "first" is a typographical error and the claim should recite "second measurements," my analysis of limitation [12d] demonstrates that Wainer discloses "associating the plurality of second images with second movement states of the mobile object using the second measurements." § XV.L.9 ([12d]).

[547] Wainer discloses using position sensor 31 with **displacement detector 32** for respiratory gating and sensor 36 with **wave detector 37** for cardiac gating. Wainer, 8:40-9:20, Fig. 6.

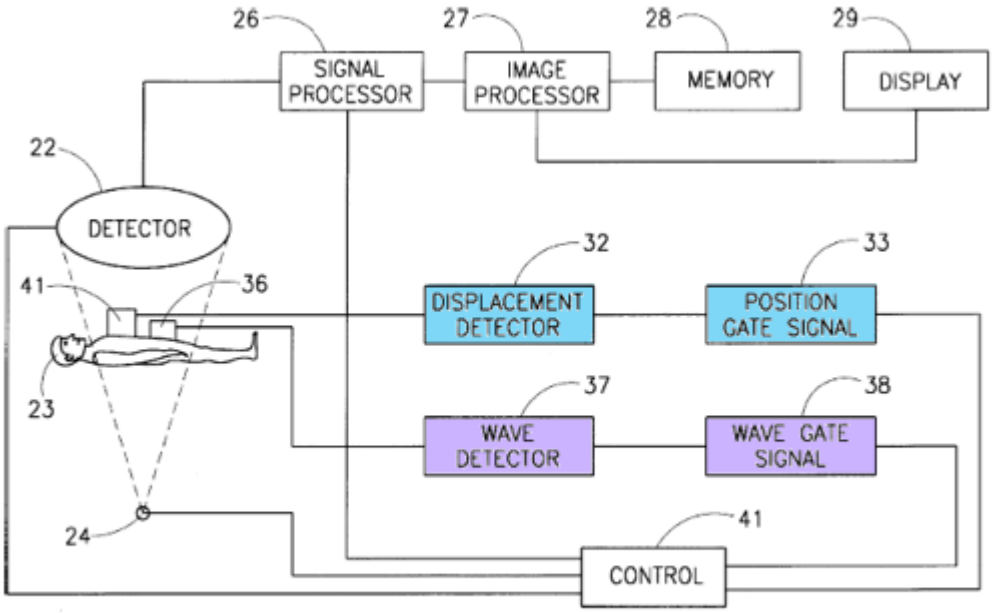


FIG.6

Wainer, Fig. 6 (annotated)

[548] Measurements from position sensor 31 and **displacement detector 32** are the "first measurements" of limitation [1a-ii]. § XV.A.2-XV.A.4 (Ground 4, [1a-i]-[1a-iii]). When gating for both respiratory and cardiac motion, Wainer windows or "bins" projections by both the phase of the breathing cycle and the phase of the cardiac cycle before reconstructing images. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. For example, Wainer bins projections for a "full inhalation" phase of the breathing cycle into different phases of a cardiac cycle. Windowing or binning

projections was a long-known and well-known technique. *E.g.*, Ex-1008 (Bushberg textbook), 453, 696-699; Ex-1011, 367 (binning PET projections for respiration); Ex-1012 (same); Ex-1014, 1920-21 (same).

[549] Accordingly, Wainer "associate[es] the plurality of second images with second movement states of the mobile object using the first [sic] measurements," as recited in [1d], when gating functional images (e.g., STET) for both cardiac and respiratory motion by windowing or binning these images into phases of the respiratory cycle.

10. [1e] forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states,

[550] In my opinion, Wainer discloses and render obvious "forming an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement measurements, and said second movement states," as recited in [1e].

[551] I identify two ways in which Wainer discloses and renders this limitation obvious, discussed below: (a) a volume image formed from a plurality of fused dual-gated functional and structural slice images, and (b) a fused image formed

from multiple dual-gated functional images and dual-gated structural images at different phases of a breathing cycle.

[552] First, I will show fused slice images formed from dual gated images would have been obvious. Wainer implements respiratory gating (first measurements and first movement states) and cardiac gating (second measurements and second movement states) of structural images (first images) and functional images (second images). §§ XV.A.2-XV.A.4 ([1a-i]-[1a-iii]), XV.A.6-XV.A.8 ([1c-i]-[1c-iii]). That is, Wainer creates dual-gated images. *E.g.*, Wainer, 3:40-41 ("in a preferred embodiment of the invention, image acquisition is gated to body rhythm***s*** and motion***s***."), 8:38-39 (same), 8:60-62 ("FIG. 6 indicates in simplified block diagram form a STET system 21 equipped to accomplish either cardiac or respiratory gating ***or both.***"), Fig. 6. Wainer teaches gating reduces image smearing. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. Wainer also teaches to fuse (e.g., superimpose) dual-gated images Wainer 7:32-41, Figs 4a, 4b, claims 1, 6-7. Wainer discloses its gated structural and functional images may be "automatically" combined when implementing gating because this registers the images to the same motion state and removes artifacts. Wainer, 3:56-60, 6:5-52. In view of these teachings, a POSITA would have combined dual-gated structural and functional images.

[553] I note that limitation [1e] requires forming "***an*** image based on said ***plurality*** of first images . . . and on said ***plurality*** of second images," but an image formed from a dual gated structural image and a dual gated functional image is based on only one "first image" and one "second image." However, Wainer still discloses and renders this requirement obvious in two ways: (a) a volume image formed from a plurality of fused dual-gated structural and functional slice images is "***an*** image based on said ***plurality*** of first images . . . and on said ***plurality*** of second images," and (b) a fused image formed from dual-gated structural and functional slice images at different time points is likewise "***an*** image based on said ***plurality*** of first images . . . and on said ***plurality*** of second images."

a. Wainer teaches fused dual-gated structural and functional volume images, which discloses and renders obvious [1e]

[554] Wainer discloses and renders obvious fused dual-gated structural and functional volume images, which renders obvious [1e].

[555] Wainer discloses creating structural and functional volume images, and it provides an exemplary method: stacking 2D slices to render 3D images. Wainer, 6:53-7:32; § X.C (Overview of Wainer (Ex-1005, U.S. 5,871,013)). Wainer explains "[t]ypically a three dimensional image is acquired and processed as a series of two dimensional slices." Wainer, 6:53-55. Such slice-by-slice volume rendering was long known. Muehllehner, Abstract ("slice-by-slice" PET approach), 1:65-2:14

(same), 12:48-60 (same), 13:18-38 (claim 1), Figs. 2, 2a, 11-13; Ex-1019, Abstract, 2:18-33, 5:61-6:4, 6:11-25, 10:60-62, 16:62-67, Fig. 2; Ex-1020, ¶ [0081]; Ex-1008 (Bushberg textbook), 360-362; § VII (TECHNOLOGICAL BACKGROUND). And Wainer further motivates making 3D volume images by providing one advantage, noting that "the attending doctor will not have to work directly with image slices" when reviewing images. Wainer, 7:26-31.

[556] A POSITA would have found it straightforward and obvious to rely on Wainer's teachings to create volume images based on the fused images from dual-gated structural and functional slices. Doing so "form[s] an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement measurements, and said second movement states," as recited in [1e].

b. Wainer discloses and renders obvious fusing dual-gated functional and structural images at different time points, which renders obvious [1e]

[557] Wainer renders obvious superimposing dual-gated functional images and dual-gated structural image at different time points, which renders obvious [1e].

[558] Wainer teaches superimposing structural and functional images, thereby disclosing and rendering obvious superimposing dual-gated structural and functional images. Wainer, 7:32-49, Figs 4a, 4b, claims 1, 6-7. Wainer discloses

superimposing images at different time points to track radiotracer distribution. Wainer, 5:3-14 (discussing time points associated with areas 2, 2' and 6, 6'), For example, Figure 4A (below) shows superposition of functional images at different timepoints. Wainer, 4:8-11, 7:32-41, Fig. 4A. Figure 4B (below) shows superposition of a functional image and structural CT image at one timepoint. Wainer, 4:12-14, 7:33-41, Fig. 4B.

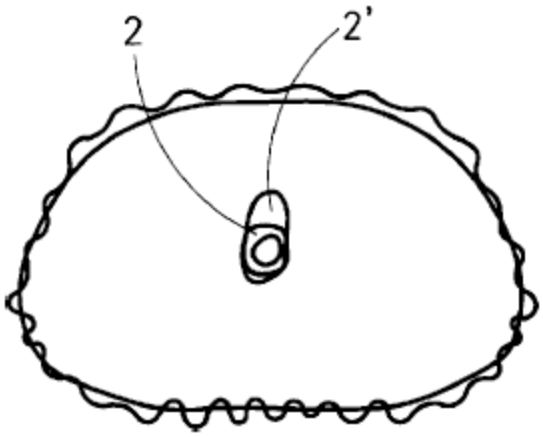


FIG.4A

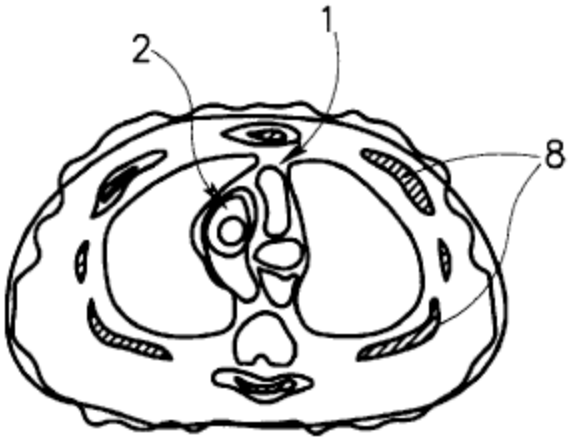


FIG.4B

Wainer, Figs. 4A-4B

[559] Wainer uses the term "processing" to describe image subtraction, superposition, outlining and coloring images, and Wainer flexibly teaches "simultaneous processing and viewing of several images at once." Wainer, 7:32-49.

[560] In my opinion, this discloses and renders obvious [1e].

[561] To the extent that Patent Owner disputes that these teachings disclose this limitation, Wainer renders it obvious. Over these flexible teachings, a POSITA would have found it obvious to superimpose multiple structural and functional dual-gated images. Wainer, 4:8-11, 7:32-41, Fig. 4A. This renders obvious [1e].

[562] In addition, Wainer teaches that structural images at different timepoints may need to be registered prior to combination owing to changes due to breathing and placement on the examination table. Wainer, 5:32-49. Wainer provides methods of registering structural images to facilitate the combination of functional images at different times to track treatment process. Wainer, 5:50-6:9. For example, Wainer teaches to register two functional images 6 and 6' taken at different time points after registration of their corresponding functional images. Wainer, 6:-6:9. A superimposed dual-gated functional image based on two dual-gated functional images registered to different dual-gated structural images is "an image [formed] based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states," as recited in [1e]. Wainer renders obvious [1e] for this additional reason.

11. [1f] wherein the first imaging technique is different from the second imaging technique.

[563] Wainer discloses "wherein the first imaging technique is different from the second imaging technique," as recited in [1f]. In my analysis, the first imaging technique is structural imaging (e.g., CT or SPTCT), while the second imaging technique is functional imaging (e.g., STET or SPECT), which are different techniques. §§ XIV.B.2-4 ([1a-i]-[1a-iii]), XIV.B.6-8 ([1c-i]-[1c-iii]).

B. Claim 2

[2] The method of claim 1, further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states.

[564] Wainer discloses "[t]he method of claim 1, further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states," as recited in claim 2.

[565] Wainer time-synchronizes structural and functional images into different windows or bins based on the phase of the respiratory cycle and cardiac cycle, which involves comparing first and second movement states (respiratory and cardiac states). When gating for both respiratory and cardiac motion, Wainer windows or "bins" projections by both the phase of the breathing cycle and the phase of the cardiac cycle before reconstructing images. Wainer, 3:33-60, 4:56-61, 8:38-

9:20, Fig. 6. For example, Wainer bins projections for a "full inhalation" phase of the breathing cycle into different phases of a cardiac cycle. Windowing or binning projections was a long-known technique. *E.g.*, Ex-1008 (Bushberg textbook), 453, 696-699; Ex-1011, 367 (binning PET projections for respiration); Ex-1012 (same); Ex-1014, 1920-21 (same).

[566] Accordingly, Wainer discloses claim 2.

C. Claim 3

[3] The method of claim 1, further comprising: forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

[567] Wainer discloses "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images," as recited in claim 3.

[568] Wainer's structural images (e.g., CT or SPTCT) are a "plurality of first images," and these images are reconstructed from transmission data. Wainer, Abstract, 2:29-3:60, Fig. 2A; § XV.A.2 ([1a-i]). Wainer thus discloses "forming first reconstructed images corresponding to said plurality of first images," as recited in claim 3.

[569] Wainer's functional images (e.g., STET or SPECT) are a "plurality of second images," and these images are reconstructed from emission data. *E.g.*, Wainer, Abstract, 2:29-3:60, 7:33-42, Fig. 4A; §§ X.C (Overview of Wainer (Ex-

1005, U.S. 5,871,013)), XV.A.6 ([1c-i]). Wainer thus discloses "forming . . . second reconstructed images corresponding to said plurality of second images," as recited in claim 3.

D. Claim 4

[4] The method of claim 3, further comprising: spatially-synchronizing said first reconstructed images and said second reconstructed images.

[570] Wainer discloses "[t]he method of claim 3, further comprising: spatially-synchronizing said first reconstructed images and said second reconstructed images," as recited in claim 4.

[571] Image registration is spatial synchronization. The '353 patent describes "spatial synchronization" as a process that registers two images, consistent with well-known methods. Ex-1001, 3:54-61; *see* Weese, ¶¶ [0073]-[0074] (describing registration); Ex-1009 (same); Ex-1011, ¶¶ [0011], [0013]-[0014], [0033]. Indeed, the patent specifically states this process "is not innovative" and the alleged "invention is not applicable to it." Ex-1001, 3:54-61.

[572] Wainer discloses registering gated images prior to combining structural and functional images. Wainer, 3:33-60, 4:56-61, 5:50-6:9, 7:32-49, 8:38-9:20. For example, Wainer states image processing like superposition may occur "[o]nce the transformation between two images are known," referring to registration. Wainer, 7:32-33. Wainer teaches that structural images at different timepoints during a

treatment regime may need to be registered prior to combination owing to changes due to breathing and placement on the examination table. Wainer, 5:32-49. Wainer provides methods of registering structural images to facilitate the combination of functional images at different times to track treatment process. Wainer, 5:50-6:9.

[573] Accordingly, Wainer discloses claim 4.

E. Claim 5

[5] The method of claim 1, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

[574] Wainer discloses "[t]he method of claim 1, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique," as recited in claim 5.

[575] Wainer's structural images (e.g., CT or SPTCT) are a "plurality of first images," and these are attenuation techniques based on transmission. Wainer, Abstract, 2:29-3:60, Fig. 2A; § XV.A.2 ([1a-i]). Wainer thus discloses "said first imaging technique is a radiation attenuation technique," as recited in claim 5.

[576] Wainer's functional images (e.g., STET) images are a "plurality of second images," and STET is an emission technique. *E.g.*, Wainer, Abstract, 2:29-3:60, 7:33-42, Fig. 4A; § XV.A.6 ([1c-i]). Wainer thus discloses "said second imaging technique is a radiation emission technique," as recited in claim 5,

F. Claim 6

[6] The method of claim 1, further comprising: spatially-

synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements.

[577] In my opinion, Wainer discloses "[t]he method of claim 1, further comprising: spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements," as recited in claim 6.

[578] Wainer's dual-gated images are formed using "first measurements" and "second measurements" from respiratory and cardiac sensor systems. §§ XV.A.2-XV.A.4 ([1a-i]-[1a-iii]) - XV.A.6-XV.A.8 ([1c-i]-[1c-iii]). Further, image registration is spatial-synchronization. § XV.D (claim 4). Accordingly, by registering dual-gated images prior to combining images, Wainer discloses "spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements," as recited in claim 6.

G. Claim 7

[7] The method of claim 1, further comprising: forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

[579] In my opinion, Wainer renders obvious "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first

measurements, said plurality of second images, and said plurality of second measurements," as recited in claim 7.

[580] Wainer uses a mathematical approach to map features of different images to one another. Wainer, 7:50-8:37 (landmark matching, surface matching, spatial parameters matching, invariant geodesic lines and point matching."). This discloses and renders obvious "displacement fields" because Wainer expresses the "transformation between two images." Wainer, 7:33-34. For example, Wainer's approaches involve surface, affine, and correlation techniques that a POSITA would recognize as "displacement fields." Wainer, 7:50-8:37.

[581] In addition, Wainer's registration "correspond[s] to "first measurements" and "second measurements" from respiratory and cardiac gating sensor data, as required in claim 7, because registration is based on dual-gated images. §§ XV.D (claim 4), XV.F (claim 6).

[582] Finally, Wainer's registration "correspond[s]" to "first images" and "second images," as required in claim 7. Wainer teaches registration can be applied to structural or functional images—i.e. the mathematical operators ("displacement fields") correspond to structural or functional images. *E.g.*, Wainer, 5:50-6:9 (registering structural images and registering functional images), 7:50-8:37.

[583] Accordingly, Wainer discloses and renders obvious claim 7.

H. Claim 8

[8] The method of claim 7, wherein said forming an image of the mobile object comprises combining said displacement fields.

[584] In my opinion, Wainer renders obvious "[t]he method of claim 7, wherein said forming an image of the mobile object comprises combining said displacement fields," as recited in claim 8.

[585] As discussed for claim 7, Wainer's registration techniques involve implementing displacement fields. § XV.G (claim 7). This comprises "combining" such fields because it accounts for displacement from one phase to the next. Ex-1001, 7:24-29; § XV.G (claim 7). Accordingly, Wainer renders obvious claim 8.

I. Claim 9

[9] The method of claim 7, wherein said forming displacement fields comprises:
estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields

[586] In my opinion, Wainer renders obvious "[t]he method of claim 7, wherein said forming displacement fields comprises: estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields," as recited in claim 9.

[587] As explained in reference to claim 7, Wainer uses a mathematical approach to map features of different images to one another that teach the claimed

"displacement fields." Wainer, 7:50-8:37 (landmark matching, surface matching, spatial parameters matching, invariant geodesic lines and point matching."). § XV.G (claim 7). This discloses and renders obvious displacement fields that express the "transformation between two images." Wainer, 7:33-34. For example, Wainer's approaches involve surface, affine, and correlation techniques that a POSITA would recognize as "displacement fields. Wainer, 7:50-8:37

[588] Further, as explained for [1e], Wainer superimposes dual-gated functional images registered to different dual-gated structural images. Wainer, 4:8-11, 7:32-41, Fig. 4A; § XV.A.10.b ([1e] analysis on superimposed images). When registering these images before combining them, Wainer "estimate[es] movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields," as recited in claim 9. That is, because this registration and fusion is based on two functional images, two structural images, and cardiac and respiratory sensor measurements, Wainer discloses and renders obvious claim 9.

J. Claim 10

[10] The method of claim 9, wherein at least one of said movement estimates is formed relative to a reference time.

[589] In my opinion Wainer discloses "[t]he method of claim 9, wherein at least one of said movement estimates is formed relative to a reference time," as recited in claim 10.

[590] Wainer's images are gated, i.e. divided into phases of a breathing and/or cardiac cycle. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §§ XV.A.2-XV.A.4 ([1a-i]-[1a-iii]), XV.A.6-XV.A.8 ([1c-i]-[1c-iii]). A phase is a "reference time," as claimed. When determining transformations for registration based on gated images, Wainer forms movement estimates relative to a phase, which discloses claim 10.

K. Claim 11

[11] The method of claim 1, wherein the first sensor system is different from the second sensor system.

[591] Wainer discloses "[t]he method of claim 1, wherein the first sensor system is different from the second sensor system," as recited in claim 11.

[592] Wainer uses different first and second sensor systems: position sensor 31 and **displacement detector 32** for respiratory gating and a sensor 36 and **wave detector 37** for cardiac gating. Wainer, 9:6-20, Fig. 6; §§ XV.A.2-XV.A.4 ([1a-i]-[1a-iii]) - XV.A.6-XV.A.8 ([1c-i]-[1c-iii]). Wainer thus discloses claim 11.

L. Claim 12

1. [12p] An apparatus to form an image of a mobile object, comprising:

[593] Wainer discloses and renders obvious [12p], as discussed for [1p]. § XV.A.1 ([1p]).

2. [12a-i] means for obtaining a plurality of first images of the mobile object using a first imaging technique;

[594] Wainer discloses [12a-i], as discussed for [1a-i]. § XV.A.2 ([1a-i]).

[595] Limitation [12a-i] would have been construed as a means-plus-function term and has the function "obtaining a plurality of first images of the mobile object using a first imaging technique." § IX.A.1 ([12a-i], claim construction). Wainer discloses this function, as discussed for [1a-i]. § XV.A.2 ([1a-i]).

[596] The corresponding structure of this term includes an attenuation or emission radiation source and detector, gantry, processor, and memory. § IX.A.1 ([12a-i], claim construction). Wainer discloses obtaining structural images such as "X-ray CT image" or SPTCT images. *E.g.*, Wainer, 6:5-18. A detector, radiation source, and associated equipment was necessary for obtaining these images, as was conventional at the time. § VII (TECHNOLOGICAL BACKGROUND). And Wainer discloses a detector in the context of STET imaging. Wainer, 8:38-9:20, Fig. 6.

[597] Accordingly, a POSITA would have understood Wainer discloses a detector and radiation source that perform "obtaining a plurality of first images of the mobile object using a first imaging technique," as discussed for [1a-i]. § XV.A.2 ([1a-i]).

3. [12a-ii] means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images,

[598] Wainer discloses [12a-ii], as discussed for [1a-ii]. § XV.A.2 ([1a-ii]).

[599] Limitation [12a-ii] would have been construed as a means-plus-function term and has the function "obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images." § IX.A.2IX.A.1 ([12a-ii], claim construction). Wainer discloses this function, as discussed for [1a-ii]. § XV.A.3 ([1a-ii]).

[600] The corresponding structure of this term includes a breathing, pressure, or electrocardiogram sensor. § IX.A.2 ([12a-ii], claim construction). Position sensor 31 is a sensor that performs "obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images," as discussed for [1a-ii]. § XV.A.3 ([1a-ii]).

4. [12a-iii] the means for obtaining the plurality of first measurements being independent from the first imaging technique;

[601] Wainer discloses [12a-iii], as discussed for [1a-iii]. § XV.A.4 ([1a-iii]).

5. [12b] means for associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

[602] Wainer discloses [12b], as discussed for [1b]. § XV.A.5 ([1b]).

[603] The term "means for associating the plurality of first images with first movement states of the mobile object," as recited in limitation [12b], would have been construed as a means-plus-function term and has the function "associating the plurality of first images with first movement states of the mobile object." § IX.A.3 ([12b], claim construction). Wainer discloses this function, as discussed for [1b]. § XV.A.5 ([1b]).

[604] I have been asked to assume the corresponding structure includes a computer programmed to perform the associating. § IX.A.3 ([12b], claim construction). Wainer discloses computer processors and memory to perform its methods. Wainer, 6:65-67, 7:26-31, 7:41-49, 9:1-20 (image processor 27, with processors and memory).

[605] Accordingly, Wainer discloses a computer programmed to perform "associating the plurality of first images with first movement states of the mobile object," as discussed for [1b]. § XV.A.5 ([1b]).

6. [12c-i] means for obtaining a plurality of second images of the mobile object using a second imaging technique;

[606] Wainer discloses [12c-i], as discussed for [1c-i]. § XV.A.6 ([1c-i]).

[607] Limitation [12c-i] would have been construed as a means-plus-function term and has the function "obtaining a plurality of second images of the mobile object using a second imaging technique." § XV.A.6 ([12c-i], claim construction). Wainer discloses this function, as discussed for [1c-i]. § XV.A.6 ([1c-i]).

[608] The corresponding structure of this term includes an attenuation or emission radiation source and detector, gantry, processor, and memory. § IX.A.4 ([12c-i], claim construction). Wainer's conventional STET system discloses a detector 22 and radiation "emanating from a patient" (a radiation source) for obtaining functional images, and it discloses an image processor 27 for processing data, and a gantry was required. Wainer, 1:17-52 (detectors and radiation), 8:38-9:20, Fig. 6; §§ VII (TECHNOLOGICAL BACKGROUND), XV.A.6 ([1c-i]);

[609] Accordingly, Wainer discloses an attenuation or emission radiation source and detector, gantry, processor, and memory that perform "obtaining a plurality of second images of the mobile object using a second imaging technique," as discussed for [1c-i]. § XV.A.6 ([1c-i]).

7. [12c-ii] means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images,

[610] Wainer discloses [12c-ii], as discussed for [1c-ii]. § XV.A.7 ([1c-ii]).

[611] Limitation [12c-ii] would have been construed as a means-plus-function term and has the function "obtaining a plurality of second measurements

corresponding to movements of the mobile object while obtaining the plurality of second images." § IX.A.5 ([12c-ii], claim construction). Wainer discloses this function, as discussed for [1c-ii]. § XV.A.7 ([1c-ii]).

[612] The corresponding structure of this term includes a breathing, pressure, or electrocardiogram sensor. § IX.A.5 ([12c-ii], claim construction). Cardiac sensor 36 is an electrocardiogram sensor that performs "obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images," as discussed for [1c-ii]. § XV.A.7 ([1c-ii]).

8. [12c-iii] the means for obtaining the plurality of second measurements being independent from the second imaging technique;

[613] Wainer discloses [12c-iii], as discussed for [1c-iii]. § XV.A.8 ([1c-iii]).

9. [12d] means for associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements; and

[614] Wainer discloses [12d] for reasons provided for [1d]. § XIV.B.9 ([1d]).

[615] The "means for associating the plurality of second images with second movement states of the mobile object" of [12d] would have been construed as a means-plus-function term and has the function "associating the plurality of second images with second movement states of the mobile object, the second movement

states being determined by the second measurements." § IX.A.6 ([12d], claim construction). Wainer discloses this function, as discussed for [1d]. § XV.A.9 ([1c-ii]).

[616] Limitation [12d] requires "the second movement states being determined by the ***second*** measurements," while [1d] requires "associating the plurality of second images with second movement states of the mobile object using the ***first*** measurements." But the same processes in Wainer that disclose [1d] also disclose the function of [12d] because gating for both respiratory and cardiac motion windows or "bins" projections by both the phase of the breathing cycle and the phase of the cardiac cycle. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; § XV.A.9 ([1d]).

[617] I have been asked to assume the structure corresponding to the function "associating the plurality of second images with second movement states of the mobile object" includes a computer programmed to perform the associating. § IX.A.6 ([12d], claim construction). Wainer discloses it because Wainer implements its methods on computerized systems, as discussed for [12b]. § XV.L.5 ([12b])

[618] Accordingly, Wainer discloses a computer programmed to perform "associating the plurality of first images with first movement states of the mobile object," as discussed for [1d]. § XV.A.9 ([1d]).

10. [12e] means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,

[619] Wainer discloses [12e], as discussed for [1e]. § XV.A.10 ([1e]).

[620] Limitation [12e] would have been construed as a means-plus-function term and has the function "forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states." § IX.A.7 ([12e], claim construction). Wainer discloses this function, as discussed for [1e]. § XV.A.10 ([1e]).

[621] I have been asked to assume the corresponding structure includes a computer programmed to perform the forming. § IX.A.7 ([12e], claim construction). Wainer discloses it because Wainer implements its methods on computerized systems, as discussed for [12b]. § XV.L.5 ([12b]).

[622] Accordingly, Wainer discloses a processor and a computer programmed to perform "forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated

plurality of second measurements, and said second movement states," as discussed for [1e]. § XV.A.10 ([1e]).

11. [12f] wherein the first imaging technique is different from the second imaging technique.

[623] Wainer discloses [12f], as discussed for [1f]. § XV.A.11 ([1f]).

M. Claim 13 [13] The apparatus of claim 12, further comprising: means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

[624] Wainer discloses claim 13, as discussed for claim 3. § XV.C (claim 3).

[625] Claim 13 would have been construed as a means-plus-function term and has the function "forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images." § IX.A.8 (claim 13, claim construction). Wainer discloses this function, as discussed for claim 3. § XV.C (claim 3).

[626] I have been asked to assume the corresponding structure includes a computer programmed to perform the forming. § IX.A.8 (claim 13, claim construction). Wainer discloses it because Wainer implements its methods on computerized systems, as discussed for [12b]. § XV.L.5 ([12b]).

[627] Accordingly, Wainer discloses a computer programmed to perform "forming first reconstructed images corresponding to said plurality of first images

and second reconstructed images corresponding to said plurality of second images," as discussed for claim 3. § XV.C (claim 3).

N. Claim 14 [14] The apparatus of claim 12, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

[628] Wainer discloses claim 14, as discussed for claim 5. § XV.E (claim 5).

O. Claim 15 [15] The apparatus of claim 12, further comprising: means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

[629] Wainer renders obvious claim 15, as discussed for claim 7. § XV.G (claim 7).

[630] Claim 15 would have been construed as a means-plus-function term and has the function "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements." § IX.A.9 (claim 15, claim construction). Wainer renders obvious this function, as discussed for claim 7. § XV.G (claim 7).

[631] I have been asked to assume the corresponding structure includes a computer programmed for forming displacement fields. § IX.A.9 (claim 15, claim construction). Wainer discloses it because Wainer implements its methods on computerized systems, as discussed for [12b]. § XV.L.5 ([12b]).

[632] Accordingly, a POSITA would have understood Wainer renders obvious a computer programmed to perform "forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements," as discussed for claim 7. § XV.G (claim 7).

P. Claim 16 [16] The apparatus of claim 15, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields.

[633] Wainer renders obvious claim 16, as discussed for claim 8. § XV.H (claim 8).

[634] Claim 16 would have been construed as a means-plus-function term and has the function "combining said displacement fields." § IX.A.10 (claim 16, claim construction). Wainer renders obvious this function, as discussed for claim 8. § XV.H (claim 8).

[635] I have been asked to assume the corresponding structure includes a computer programmed for combining displacement fields. § IX.A.10 (claim 16, claim construction). Wainer discloses it because Wainer implements its methods on computerized systems, as discussed for [12b]. § XV.L.5 ([12b]).

[636] Accordingly, a POSITA would have understood Wainer renders obvious a computer programmed for "combining said displacement fields," as discussed for claim 8. § XV.H (claim 8).

Q. Claim 17 [17] The apparatus of claim 15, wherein said means for forming displacement fields comprises: means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields.

[637] Wainer renders obvious claim 17, as discussed for claim 9. § XV.I (claim 9).

[638] Claim 17 would have been construed as a means-plus-function term and has the function "estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields." § IX.A.11 (claim 17, claim construction). Wainer renders obvious this function, as discussed for claim 9. § XV.I (claim 9).

[639] I have been asked to assume the corresponding structure computer programmed for estimating movement based on images and measurements processor and non-transitory memory. § IX.A.11 (claim 17, claim construction). Wainer discloses it because Wainer implements its methods on computerized systems, as discussed for [12b]. § XV.L.5 ([12b]).

[640] Accordingly, a POSITA would have understood Wainer renders obvious a computer programmed for "estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images,

said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields," as discussed for claim 9. § XV.I (claim 9).

R. Claim 18 [18] The apparatus of claim 17, wherein at least one of said movement estimates is to be formed relative to a reference time.

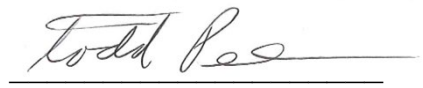
[641] Wainer discloses claim 18, as discussed for claim 10. § XV.J (claim 10).

XVI. CONCLUSION

[642] For the reasons set forth above, in my opinion, a POSITA would have found claims 1-18 of the '353 patent obvious.

[643] In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

[644] I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: May 30, 2025 By: 

Todd E. Peterson, Ph.D.