

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

**PETITION FOR *INTER PARTES* REVIEW**

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| <b>Exhibit</b> | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                           |
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| Ex-1001        | U.S. Patent No. 8,265,353 (“the ’353 patent”)                                                                                                                                                                                                                                                                                                                                |
| Ex-1002        | Prosecution History of the ’353 Patent                                                                                                                                                                                                                                                                                                                                       |
| Ex-1003        | Declaration of Todd Peterson                                                                                                                                                                                                                                                                                                                                                 |
| Ex-1004        | Curriculum Vitae of Todd Peterson, PhD                                                                                                                                                                                                                                                                                                                                       |
| 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. <i>The essential physics of medical imaging</i> , Lippincott Williams & Wilkins. 2d Ed. (2002)                                                                                                                                                                                                                                                  |
| Ex-1009        | Mattes, David, et al. “Nonrigid multimodality image registration,” <i>Medical imaging 2001: image processing</i> . Vol. 4322. Spie (2001)                                                                                                                                                                                                                                    |
| Ex-1010        | Katsaggelos, Aggelos K. “Iterative image restoration algorithms,” <i>Optical engineering</i> 28.7, 735-748 (1989)                                                                                                                                                                                                                                                            |
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| Ex-1012        | Woo, Sang-Keun, et al. “Development of a motion detecting system for respiratory-gated PET using laser optical displacement sensor,” <i>2003 IEEE Nuclear Science Symposium, Conference Record</i> (IEEE Cat. No. 03CH37515), Vol. 3. IEEE (2003) <a href="https://doi.org/10.1109/NSSMIC.2003.1352255">https://doi.org/10.1109/NSSMIC.2003.1352255</a>                      |

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| 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,” <i>The Journal of Nuclear Medicine</i> , 43 (7), 876-881 (July 2002)            |
| Ex-1014 | Schöder, H., Erdi, Y.E., Larson, S.M. et al. “PET/CT: a new imaging technology in nuclear medicine,” <i>European Journal of Nuclear Medicine and Molecular Imaging</i> , 30, 1419–1437 (2003), <a href="https://doi.org/10.1007/s00259-003-1299-6">https://doi.org/10.1007/s00259-003-1299-6</a>                               |
| Ex-1015 | Osman, Medhat M., et al. “Respiratory motion artifacts on PET emission images obtained using CT attenuation correction on PET-CT,” <i>European journal of nuclear medicine and molecular imaging</i> 30, 603-606 (2003), <a href="https://doi.org/10.1007/s00259-002-1024-x">https://doi.org/10.1007/s00259-002-1024-x</a>     |
| Ex-1016 | Beyer, Thomas, et al. “Dual-modality PET/CT imaging: the effect of respiratory motion on combined image quality in clinical oncology,” <i>European journal of nuclear medicine and molecular imaging</i> 30, 588-596 (2003), <a href="https://doi.org/10.1007/s00259-002-1097-6">https://doi.org/10.1007/s00259-002-1097-6</a> |
| Ex-1017 | Ritchie CJ, Hsieh J, Gard MF, et al: “Predictive respiratory gating: A new method to reduce motion artifacts on CT scans,” <i>Radiology</i> 190:847-852 (1994), <a href="https://doi.org/10.1148/radiology.190.3.8115638">https://doi.org/10.1148/radiology.190.3.8115638</a>                                                  |
| 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.                                                                                                                                                                                                                                                                 |

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| Ex-1021 | Goerres, Gerhard W., et al. “PET-CT image co-registration in the thorax: influence of respiration,” <i>European journal of nuclear medicine and molecular imaging</i> 29, 351-360 (2002), 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,” <i>Seminars in radiation oncology</i> , Vol. 14. No. 1. WB Saunders, (2004), <a href="https://doi.org/10.1053/j.semradonc.2003.10.004">https://doi.org/10.1053/j.semradonc.2003.10.004</a> |
| Ex-1023 | Kachelrieß, Marc, et al. “Kymogram detection and kymogram-correlated image reconstruction from subsecond spiral computed tomography scans of the heart,” <i>Medical Physics</i> . 29.7, 1489-1503 (2002), <a href="https://doi.org/10.1118/1.1487861">https://doi.org/10.1118/1.1487861</a>                      |
| Ex-1024 | Excerpts of Plaintiff’s Disclosure of Asserted Claims and Infringement Contentions, <i>Longhorn Automotive Group LLC v. Volkswagen AG</i> , 2:24-cv-00933 (E.D. Tex.) (Apr. 4, 2025)                                                                                                                             |
| Ex-1025 | Declaration of Shauna L. Wiest Regarding Beyer (Ex-1016) and Osman (Ex-1015)                                                                                                                                                                                                                                     |
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| Ex-1029 | Declaration R. Watters Regarding Chen (Ex-1022)                                                                                                                                                                                                                                                                  |

All emphasis, annotations, and colors in text and figures added herein unless otherwise stated. Figure annotations correspond to those added in Dr. Peterson’s declaration (Ex-1003).

## **I. INTRODUCTION**

The '353 patent combines known medical imaging with known motion measurement using known techniques. No advances are described, much less claimed. The patent's generic claims are unpatentable many ways.

Weese discloses claim limitations [1d] and [1e] *thirteen* ways. Weese corrects motion artifacts in CT and PET images using motion models built from sensor data and fuses these images. The '353 patent contains nothing beyond Weese's disclosure. Indeed, nothing described or claimed in the '353 patent was new or inventive. Claims 1-18 should be canceled.

## **II. LEVEL OF ORDINARY SKILL**

A person of ordinary skill in the art ("POSITA") would have possessed at least a four-year degree in physics, biophysics, medical physics, or a related field, and two years of experience in developing and/or applying computed tomography methods. Peterson, [0054]-[0056]. Additional education and professional experience are interchangeable. *Id.*

## **III. STATEMENT OF RELIEF REQUESTED**

Petitioner requests review of claims 1-18 as follows. Weese is pre-AIA 35 U.S.C. §102(e) prior art. Wainer and Muehllehner are pre-AIA §102(b) prior art.

| <b>Exhibit</b> | <b>Prior Art</b>                                   |
|----------------|----------------------------------------------------|
| Ex-1005        | U.S. Patent Publication No. 2005/0226527 (“Weese”) |
| Ex-1006        | U.S. Patent No. 5,744,802 (“Muehllehner”)          |
| Ex-1007        | U.S. Patent No. 5,871,013 (“Wainer”)               |

| <b>Grounds</b>       |   | <b>Challenged Claims</b> | <b>Basis</b> | <b>Prior Art</b>      |
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| <b>Weese Grounds</b> | 1 | 1-18                     | §103         | Weese                 |
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| <b>Wainer Ground</b> | 4 | 1-18                     | §103         | Wainer                |

#### **IV. THE ’353 PATENT**

##### **A. Priority and Inventorship**

The ’353 patent was filed September 30, 2004 and issued September 11, 2012. Ex-1001, Cover, 8:1-10:28. While it claims priority to French application 03 50631, filed October 1, 2003, Patent Owner asserts priority only to September 30, 2004. Ex-1024, 6. The claims are obvious under either date. Peterson, [032]-[034].

##### **B. Purported Invention**

The ’353 patent professes to reduce motion artifacts when combining medical images. Ex-1001, Abstract, 1:5-21. The field was admittedly rich with solutions for

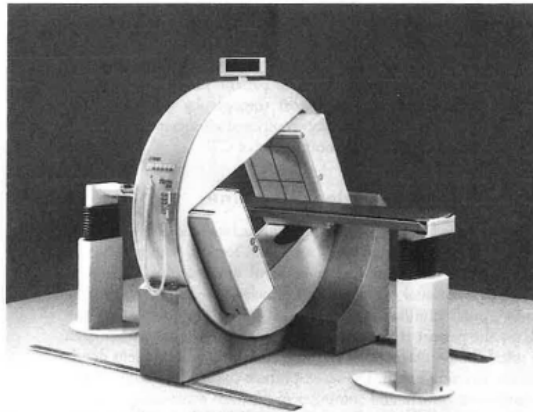
motion artifacts and image combination. Ex-1001, 1:22-2:4, 2:21-48; Peterson, [00-35]-[0036].

The independent claims form combination images “based on”: two imaging techniques, two independent “movement measurements,” and two movement states. The patent combines known “attenuative” methods (showing anatomy) with known “emissive” methods (distinguishing tissues) and use existing “superposition” techniques to facilitate diagnosis. Ex-1001, 1:8-35; Peterson, [0036]-[0040]. Acknowledging this prior art, the patent cites an article on combined PET/CT scanners from 1998. Ex-1001, 1:30-35.

The patent only purports to advance the field by applying such known reconstruction methods to emission techniques, with motion correction. Ex-1001, 2:4-7. But as discussed below, this was known in the art, too.

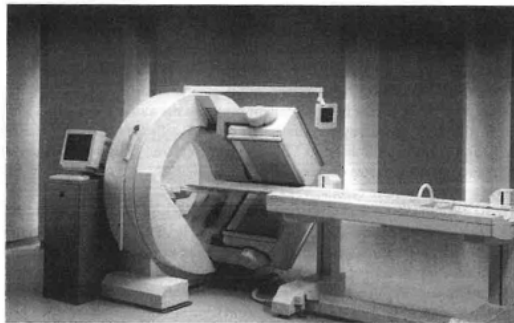
## **V. TECHNOLOGICAL BACKGROUND**

Medical imaging before the '353 patent involved using a radiation source, detectors, gantry, and image processor to collect projections, reconstruct images, and transform and combine images. Peterson, [042]-[053].

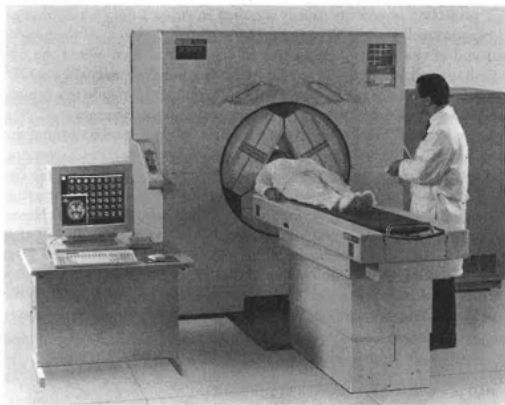


A

**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)

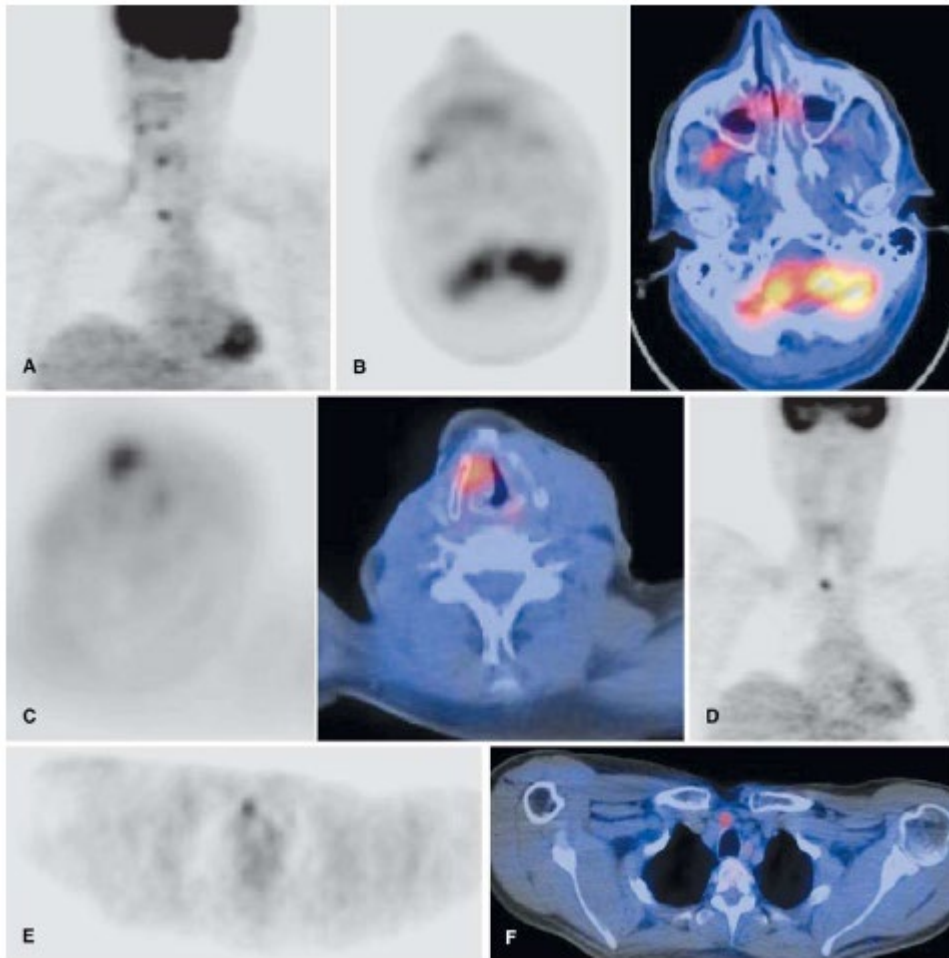
Computerized Tomography (CT) and Single Photon Emission Computed Tomography (SPECT) pass radiation through an object to form images based on

attenuation. Peterson, [0043]. This yields “structural” images showing detailed anatomy. *Id.*

Other prior techniques, like Positron Emission Tomograph (PET) and Single Photon Emission Computed Tomography (SPECT), detect radiation from ingested radioactive materials. Peterson, [044]. This yields “functional” images highlighting tissues with increased metabolic activity, which often weakly show or do not show structure. *Id.*

2D slice approaches were known. Peterson, [045]. 3D techniques were also known, including slice-by-slice volume rendering and direct 3D acquisition. Peterson, [046].

It was common to compare images from different modalities because each provides different insights. Peterson, [047]-[048]. Practitioners typically displayed images side-by-side or superimposed. *Id.*



**Ex-1014, 1423 (PET/CT fusion, color; PET, grayscale)**

When comparing and combining, it was common to “register” images to common coordinates, including images from different instruments or timepoints. Peterson, [048]. The ’353 patent recognizes registration was known: it “is not innovative”—the alleged “invention is not applicable to it.” Ex-1001, 3:54-61.

It was also understood that breathing and heartbeat motion create artifacts in images. Peterson, [049]-[052].

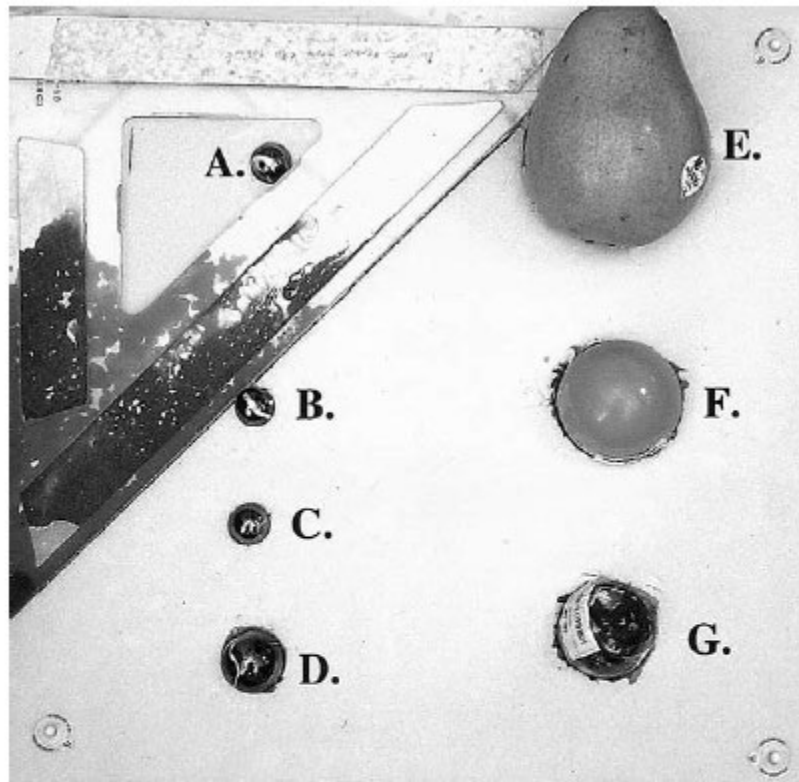


**Figure 1.** Photograph of the phantom of scanned geometric objects. Objects A through D are glass marbles. Object E is a pear (fruit) and objects F and G are rubber balls. A drafting triangle is shown in the upper left hand region of the Styrofoam block in which the objects are embedded. A rod attached 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**

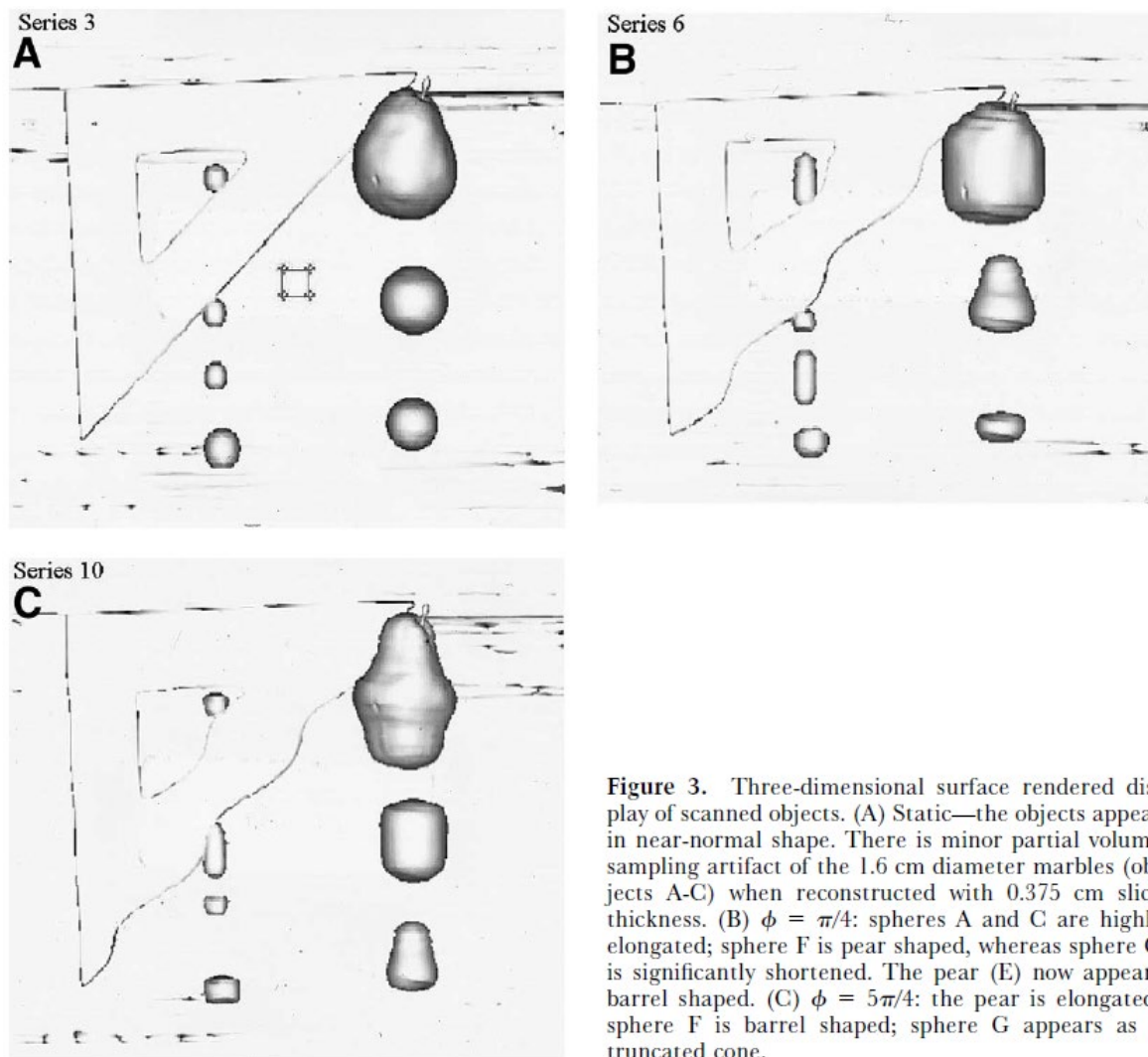


**Figure 3.** Three-dimensional surface rendered display of scanned objects. (A) Static—the objects appear in near-normal shape. There is minor partial volume sampling artifact of the 1.6 cm diameter marbles (objects A-C) when reconstructed with 0.375 cm slice thickness. (B)  $\phi = \pi/4$ : spheres 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

The art accounted for motion artifacts. Peterson, [049]-[052]. Some solutions relied on breathing protocols. Peterson, [050]. Some involved: “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. “Gating” images to body rhythms by grouping projections by

motion phase (e.g., based on sensors) was also well-known for motion correction. Peterson, [051]-[052].

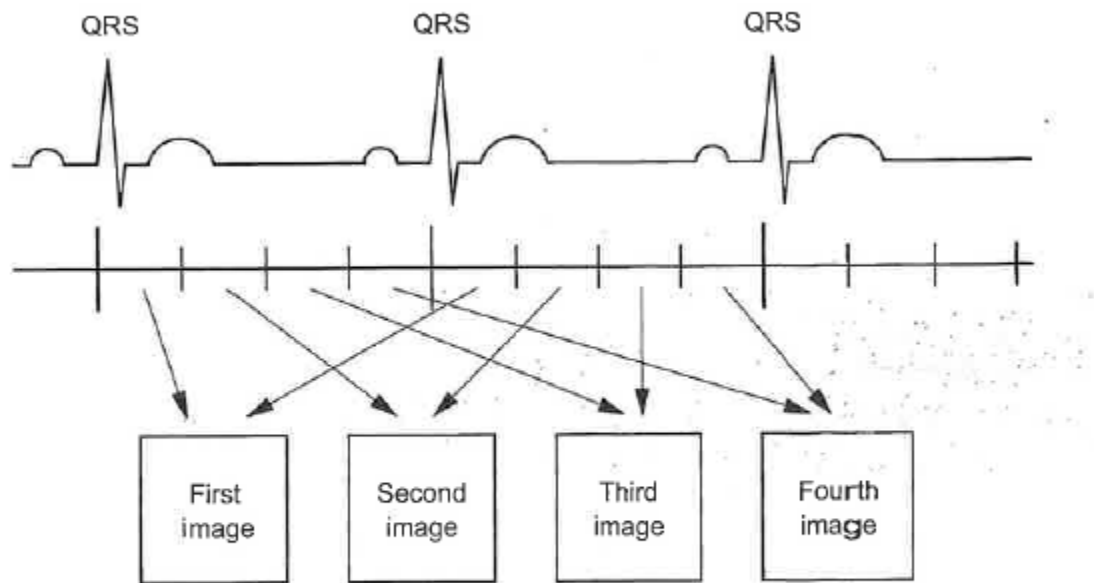


**FIGURE 21-22.** Acquisition of a gated cardiac image sequence. Only four images are shown here. Sixteen to 24 images are typically acquired.

### Ex-1008, 698 (Fig. 21-22)

These known techniques teach every claim of the '353 patent. Peterson, [051].

## VI. CLAIM CONSTRUCTION

The Board construes claims per *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). Petitioner construes certain terms reciting “means for,” where

pre-AIA 35 U.S.C. §112, ¶6 presumptively applies. *Kemco Sales, Inc. v. Control Papers Co., Inc.*, 208 F.3d 1352, 1361 (Fed. Cir. 2000).

While Petitioner does not concede the patent discloses adequate structure for purposes of definiteness, this does not prevent the Board from comparing the prior art to the claims because the art discloses the same (and more) structure as the patent. *Sisvel Int’l S.A. v. Sierra Wireless, Inc.*, 82 F.4th 1355, 1370 (Fed. Cir. 2023). Claims should only be construed to the extent necessary to resolve a controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). Because the prior art discloses the same or more structure as the ’353 patent, the Board may adjudicate the claims.

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

[12a-i] invokes §112, ¶6. Peterson, [064]-[071].

Function: “obtaining a plurality of first images of the mobile object using a first imaging technique.”

Structure: The specification describes known attenuation or emission image detectors. Ex-1001, 1:4-35, 1:41-45, 2:26-33. Attenuation and emission require detectors, a radiation source, gantry, processor, and memory. Peterson, [066]-[071]; §V. During prosecution, the applicant alleged support for [12a-i] 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.” Ex-1002, 784. Those disclosures address attenuation and emission. Ex-1002, 22-24, 37, 244.

[12a-i]’s structure includes an attenuation or emission radiation source, detector, gantry, processor, and memory. Peterson, [066]-[071]; §V.

**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”**

[12a-ii] invokes §112, ¶6. Peterson, [072]-[079].

Function: “obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images.”

Structure: The specification describes “a breathing sensor, a pressure sensor or an electrocardiogram.” 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. During prosecution, the applicant alleged support for [12a-ii] and [12a-iii] at “Fig. 1, ref. Et11; Page 5, lines 20-26; and Page 6, lines 6-13.” Ex-1002, 784. Those disclosures describe sensors. Ex-1002, 24-25, 244.

[12a-ii]’s structure includes a breathing, pressure, or electrocardiogram sensor. Peterson, [074]-[079].

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

[12b] invokes §112, ¶6. Peterson, [080]-[087].

Function: “associating the plurality of first images with first movement states of the mobile object.”

Structure: The specification describes associating images with motion, without more. Ex-1001, Figs. 1-2, 2:62-3:9, 5:4-9. During prosecution, the applicant alleged support for [12b] at “Fig. 1, ref. Et3; Fig. 2; Page 5, line 26 - page 6, line 5; Page 6, lines 13-16.” Ex-1002, 785.

Petitioner assumes [12b]’s structure includes a computer programmed to perform the associating. Ex-1008, 61-93; Peterson, [082]-[087].

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

[12c-i] invokes §112, ¶6. Peterson, [088]-[095].

Function: “obtaining a plurality of second images of the mobile object using a second imaging technique.”

Structure: The specification describes known attenuation or emission image detectors. Ex-1001, 1:4-35, 1:41-45, 2:26-33. Detectors alone are insufficient; attenuation and emission require a radiation source, gantry, processor, and memory. Peterson, [090]-[095]; §V. During prosecution, the applicant alleged support for [12c-i] 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.” Ex-1002, 784.

[12c-i]'s structure includes an attenuation or emission radiation source, detector, gantry, processor, and memory. Peterson, [090]-[095]; §V.

**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”**

[12c-ii] invokes §112, ¶6. Peterson, [096]-[103].

Function: “obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images.”

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. Examples include “a breathing sensor, a pressure sensor or an electrocardiogram.” Ex-1001, 2:59-62. During prosecution, the applicant alleged support for [12c-ii] for [12c-iii] at “Fig. 1, ref. Et12; Page 5, lines 20-26; and Page 6, lines 6-13.” Ex-1002, 785 (referring to Ex-1002, 24-25, 244). Those disclosures describe sensors. Ex-1002, 24-25, 244.

[12c-ii]'s structure includes a breathing, pressure, or electrocardiogram sensor. Peterson, [098]-[103].

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

[12d] invokes §112, ¶6. Peterson, [104]-[112].

Function: “associating the plurality of second images with second movement states of the mobile object.”

Structure: The specification describes associating images with motion, without more. Ex-1001, Figs. 1-2, 2:62-3:9, 5:4-9. During prosecution, the applicant identified 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. The applicant characterized the differences between this limitation and [12d] as non-substantive typos. Ex-1002, 832, 842; *see* Ex-1002, 675-76, 734. The applicant cited “Fig. 1, ref. Et3; Fig. 2; Page 5, line 26 - page 6, line 5; Page 6, lines 13-16” in support. Ex-1002, 785.

Petitioner assumes [12d]’s structure includes a computer programmed to perform the associating. Ex-1008, 61-93; Peterson, [106]-[112].

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,”**

[12e] invokes §112, ¶6. Peterson, [113]-[119].

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.”

Structure: During prosecution, the applicant alleged support for [12e] 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.” Ex-1002, 785 (referring to Ex-1002, 26-35, 244).

Petitioner assumes [12e]’s structure includes a computer programmed to perform the forming. Ex-1008, 61-93; Peterson, [115]-[119].

**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.”**

Claim 13 invokes §112, ¶6. Peterson, [120]-[123].

Function: “forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.”

Structure: The patent mentions image reconstruction, without more. Ex-1001, 1:61-2:7, 3:21-48, 7:24-48.

Petitioner assumes claim 13’s structure includes a computer programmed to perform the forming. Ex-1008, 61-93; Peterson, [122]-[123].

**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.”**

Claim 15 invokes §112, ¶6. Peterson, [124]-[127].

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.”

Structure: The patent describes displacement fields, without more. Ex-1001, 5:15-7:48.

Petitioner assumes claim 15’s structure includes a computer programmed for forming displacement fields. Ex-1008, 61-93; Peterson, [126]-[127].

**10. Claim 16: “means for combining said displacement fields”**

The “means for combining said displacement fields” invokes §112, ¶6. Peterson, [128]-[131].

Function: “combining said displacement fields.”

Structure: The patent describes displacement fields, without more. Ex-1001, 5:15-7:48.

Petitioner assumes claim 16’s structure includes a computer programmed for combining displacement fields. Ex-1008, 61-93; Peterson, [130]-[131].

**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.”**

Claim 17 invokes §112, ¶6. Peterson, [132]-[135].

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.”

Structure: The patent describes displacement fields and estimating movement, without more. Ex-1001, 5:15-7:48.

Petitioner assumes claim 17’s structure includes a computer programmed for estimating movement based on images and measurements. Ex-1008, 61-93; Peterson, [134]-[135].

## **VII. THE PRIOR ART**

### **A. Weese (Ex-1005)**

Weese published in English October 13, 2005, as a National Stage of PCT/IB03/03011, filed July 8, 2003, designating the U.S. Weese, Cover. Weese is pre-AIA §102(e)(1) prior art.

Weese flexibly describes ways to combine CT and PET images to correct motion artifacts. Weese, Abstract, ¶¶[0001]-[0004], Figs. 1-3; Peterson, [138]-[149]. Respiration creates “unsharp,” “blurred” images. Weese, ¶[0049]. Weese

addresses motion “in a very broad sense,” encompassing heartbeats and breathing. Weese, ¶¶[0009], [0049], [0062], Figs. 4-5. Weese seeks to improve image fusion for combination and separate CT and PET systems. Weese, ¶¶[0072]-[0074], [0080], Fig. 6. Figures 1-3 provide exemplary methods.

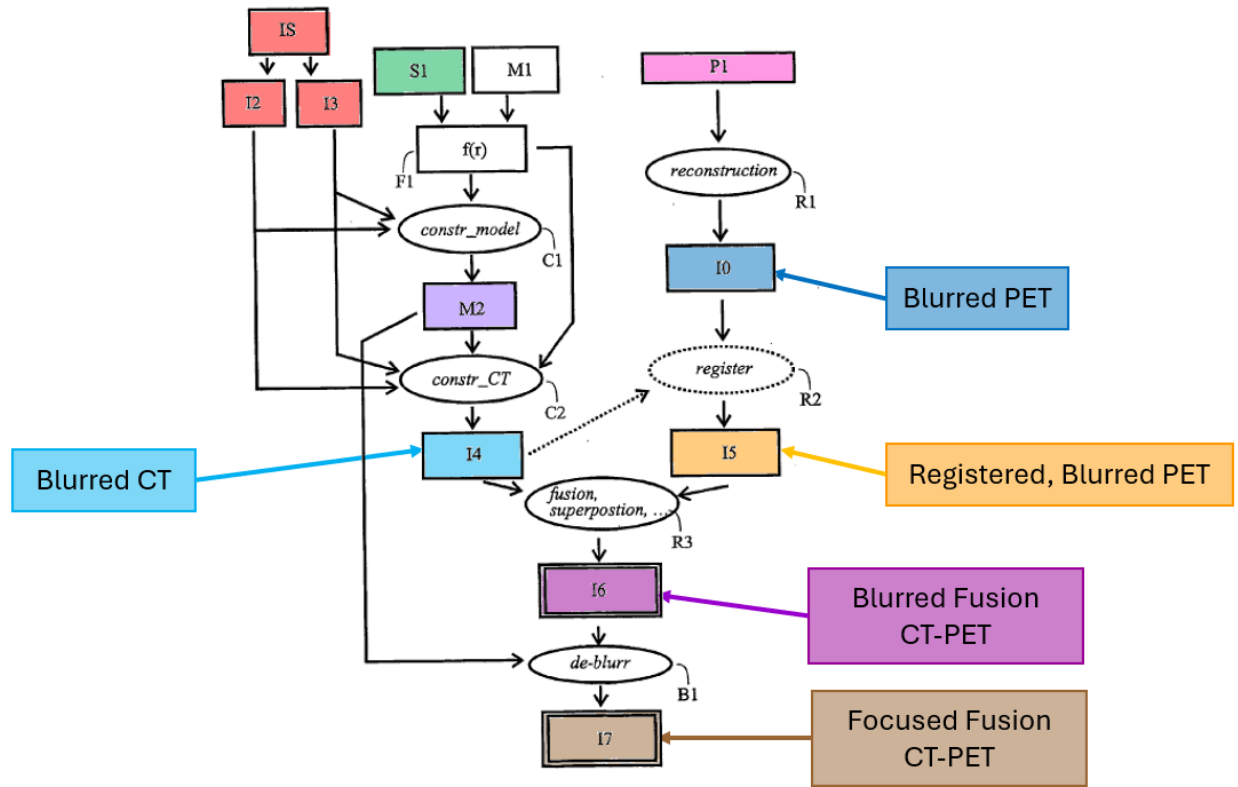


FIG.1

Weese, Fig. 1

Figure 1 depicts:

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

- ii. constructing **motion model M2** based on a “motion signal” describing “actual motion” from **sensor S1** (Weese, ¶¶[0062]-[0067]);
- iii. reconstructing motion-blurred **PET image I0** from **projections P1** (Weese, ¶¶[0048]-[0051]);
- iv. creating **blurred PET image I5** by registering **I0** to CT coordinates when CT is a separate system from PET (Weese, ¶¶[0003], [0032], [0072]-[0080], claims 6, 8; Ex-1009).
- v. using **M2** to create **blurred CT image I4**, a weighted “superposition of all states of motion” during breathing (Weese, ¶¶[0068]-[0069]);
- vi. combining **I4** with **I5** (or **I0**) to create **blurred CT-PET image I6** (Weese, ¶¶[0075]-[0076]); and
- vii. using **M2** to generate **focused CT-PET image I7** for a motion state (e.g., full inhale) from **I6** (Weese, ¶[0077]).

Peterson, [140]-[142].

Figure 2 involves **I2**, **I3**, **S1**, **M2**, **P1**, and **I0** of Figure 1. Weese, ¶¶[0078]-[0080]. Instead of combining *blurred* CT image **I4** with a *blurred* PET image, Figure 2 first *focuses* the PET image then combines it with an *already-focused* CT image. Weese, ¶¶[0078]-[0080]; Peterson, [143]. Figure 2:

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

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

Peterson, [143].

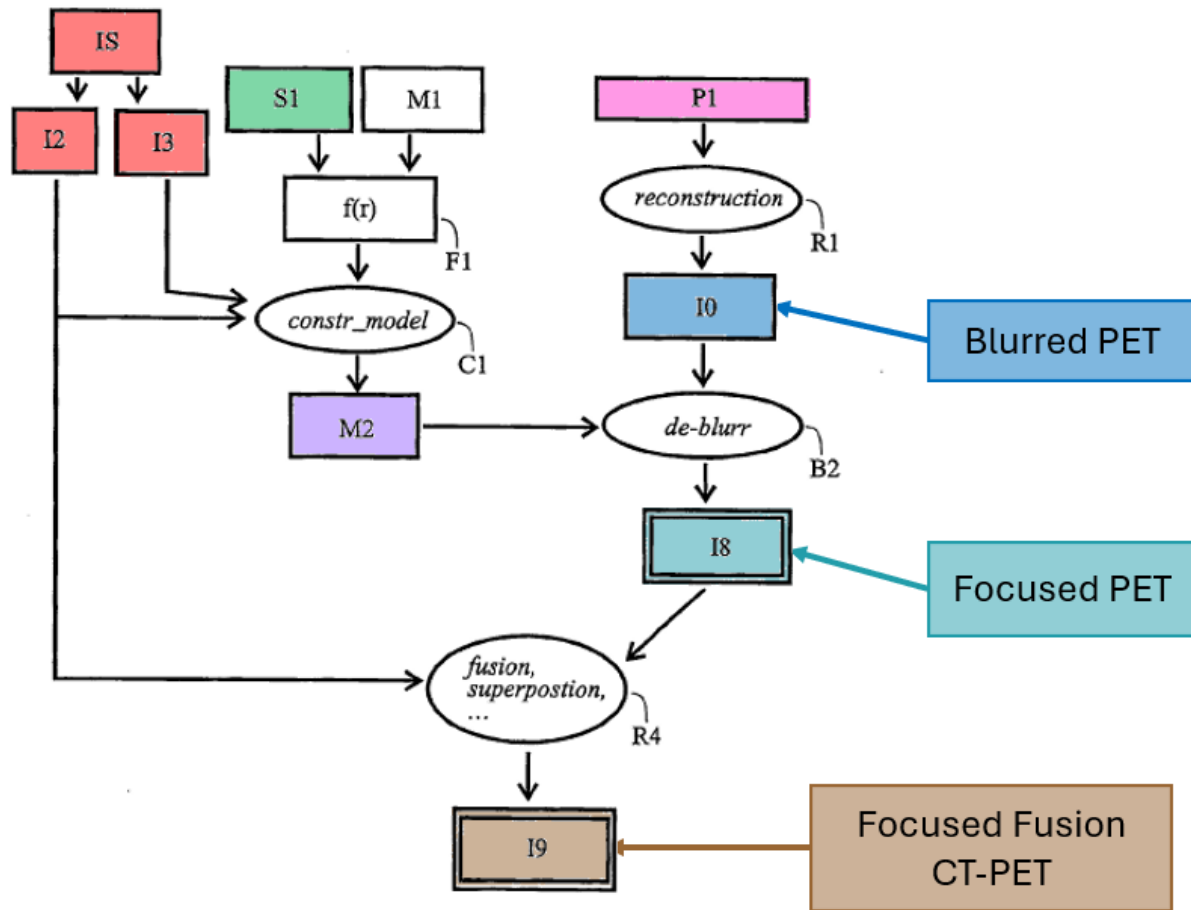


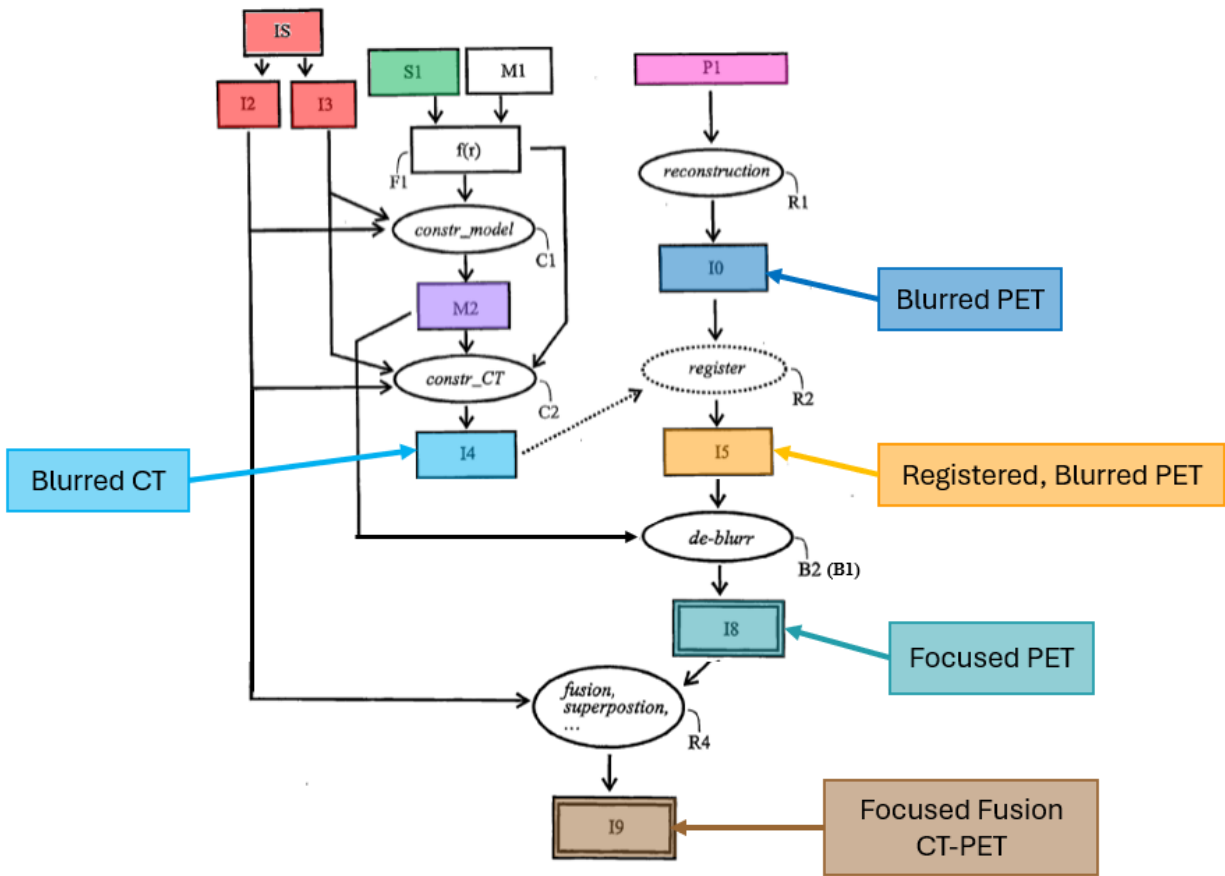
FIG.2

Weese, Fig. 2

Weese further discloses a Figure 2 “alternative,” “(not shown),” for separate CT and PET systems. Weese, ¶[0080]; Peterson, [144]-[145]. This forms **I5** by registering **I0** to coordinates of **I4** using **M2**. Weese, ¶[0080]; see Weese, ¶¶[0003],

[0032], [0077]-[0080], claims 6, 8, Fig. 1; *see* Ex-1009. It focuses **I5** to generate a **focused PET image**, which is combined with **I2** (or **I3**) to make a **focused CT-PET image**. Weese, ¶¶[0078]-[0080], Fig. 2; Peterson, [144]-[145].

A modified figure based on Figures 1-2 illustrates this embodiment:



Weese, modified Figs. 1-2

Figure 3 involves **I2**, **I3**, **S1**, **M2**, **P1**, and **I4** of Figure 1. Weese, ¶¶[0081]-[0082]; Peterson, [146]. But here, **I4** reconstructs blurred PET image **I10**. Weese, ¶¶[0047]-[0051], [0082]-[0083]. For a combination CT-PET system, Figure 3's method may be combined "at will" with Figures 1-2. Weese, ¶[0084].

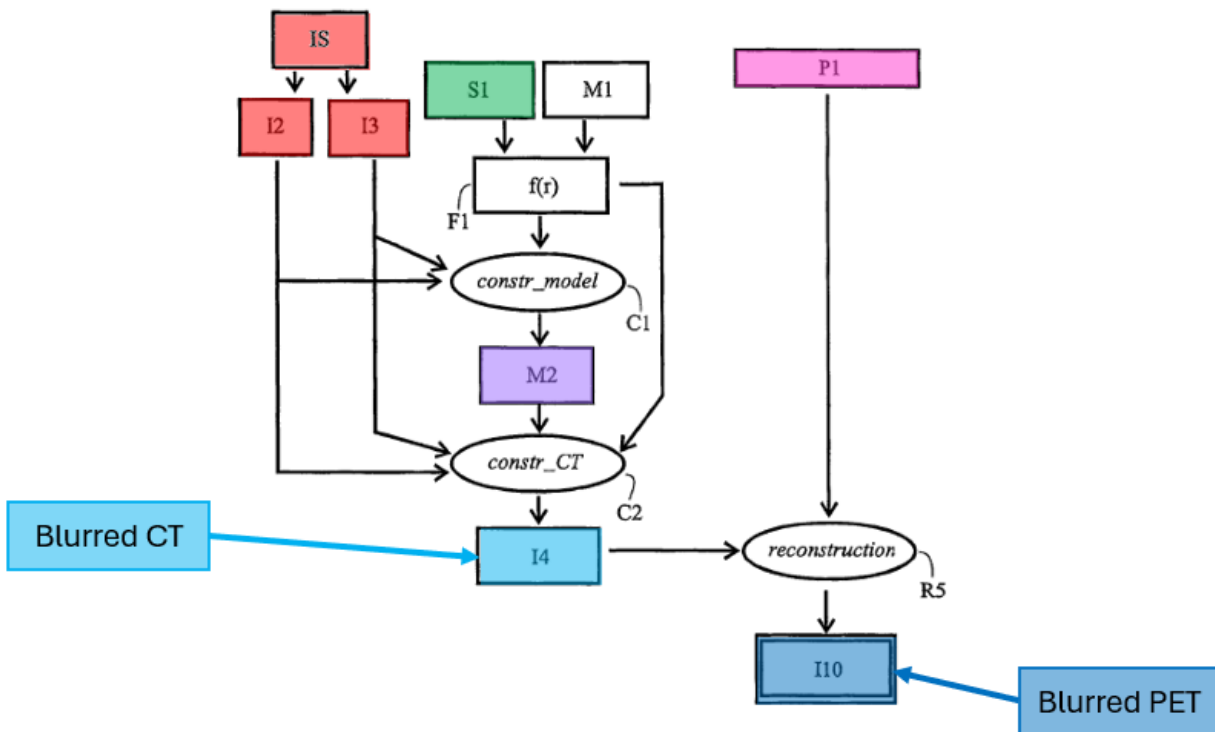


FIG.3

Weese, Fig. 3

Weese's flexible methods can be used interchangeably and in combination to achieve different views and comparisons. Weese, Abstract, ¶¶[0013], [0018]-[0019], [0029], [0075]-[0084], Figs. 1-3; Peterson, [147]-[149].

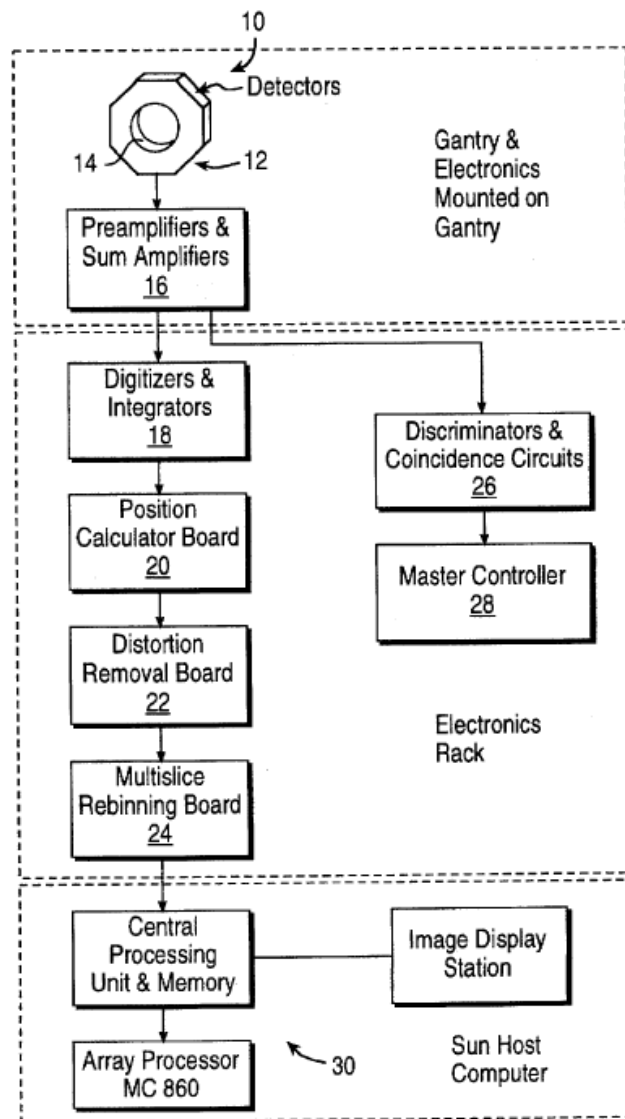
### B. Muehllehner (Ex-1006)

Muehllehner issued April 28, 1998 and is pre-AIA §102(b) prior art. Muehllehner, Cover.

Muehllehner forms three-dimensional PET images from two-dimensional slices. Abstract, 1:65-2:14, 3:27-58, 12:48-60, 13:18-38, Figs. 1-2, 2a, 11-13; Peterson, [150]-[153]. Muehllehner reduces blurring in volume images by binning

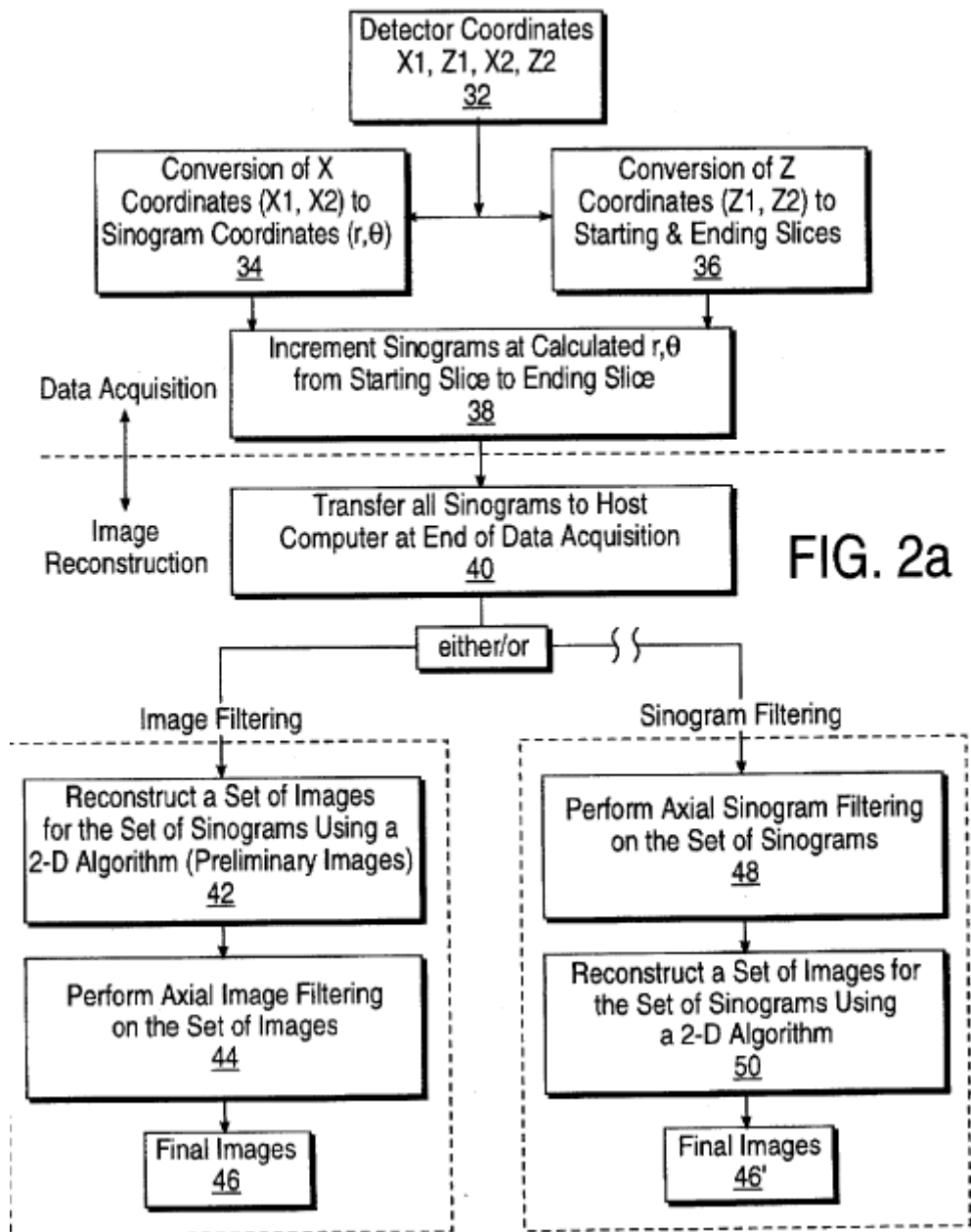
and filtering two-dimensional projections. Muehllehner, Abstract, 1:13-63, 6:49-9:3, Figs. 2-2a.

FIG. 1



Muehllehner, Fig. 1

FIG. 2



Muehllehner, Figs. 2-2a

**C. Wainer (Ex-1005)**

Wainer issued February 16, 1999 and is pre-AIA §102(b) prior art. Wainer, Cover.

Wainer registers structural (SPTCT or CT) and functional images (SPECT or STET). Wainer, 1:18-61, 2:24-53, 3:26-33, 4:23-55, 6:10-17, 9:24-31. Wainer superimposes different types of images from different timepoints. Wainer, 4:8-14, 5:3-14, 7:32-49, Fig. 4A-4B; Peterson, [154]-[158]. Wainer discloses “simultaneous processing and viewing of several images at once.” Wainer, 7:32-49. Before combining images, Wainer registers them to account for movement. Wainer, 5:32-6:9. Wainer uses sensors to gate images to different motion phases, as was conventional, which reduces “smearing” and facilitates registration. Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6; Peterson, [154]-[158].

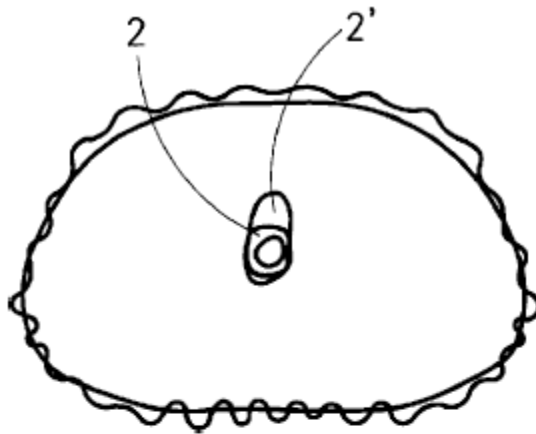


FIG. 4A

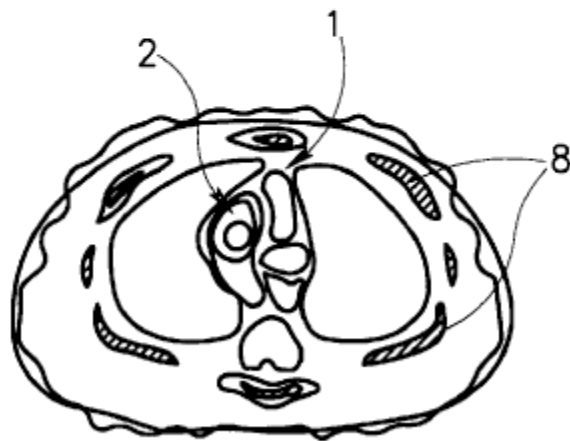


FIG. 4B

Wainer, Figs. 4A-4B

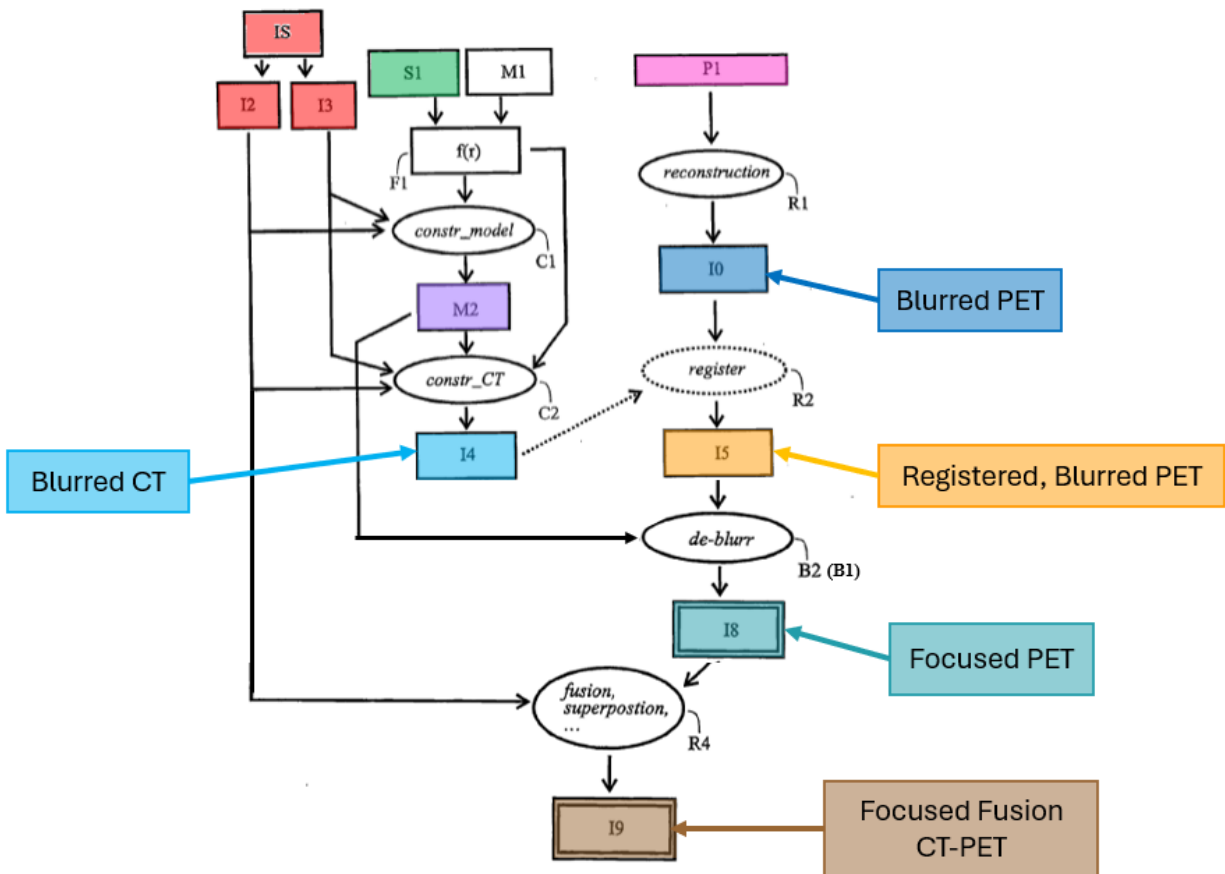
## VIII. GROUND 1 (WEESE)

### A. Overview

Weese renders claims 1-18 unpatentable in multiple ways, including for combined and separately located CT and PET systems. Peterson, [159]-[348].

Weese implements widely-known registration methods to align image coordinates for separate systems. Weese, ¶¶[0037], [0072]-[0074], [0080]; Ex-1008, 720; Ex-1009; Wainer, 2:39-53, 4:28-30, 5:28-29; Peterson, [161]-[163]. After registration, Weese uses the same motion correction and image fusion techniques as combination CT-PET systems. Weese, ¶¶[0047]-[0080], Figs. 1-2; Peterson, [163]; §VII.A.

Weese describes but does not show the below modified figure for separate CT and PET systems. Weese, ¶¶[0047]-[0052], [0062]-[0080]; Peterson, [164]-[172]; §VII.A.



Weese, modified Figs. 1-2

If Patent Owner asserts Weese does not disclose this process, POSITAs would have found it obvious. Peterson, [165]-[172].

An explicit teaching, suggestion, or motivation shows obviousness. *KSR Int’l Co. v. Teleflex, Inc.*, 550 U.S. 398, 415-422 (2007) (TSM sufficient but not necessary). Combining “adjacent” embodiments “does not require a leap of inventiveness” with reason to do so. *Boston Sci. Scimed, Inc. v. Cordis Corp.*, 554 F.3d 982, 991 (Fed. Cir. 2009). Weese provides a motivation to combine Figures 1-2 and expectation of success. Weese, ¶¶[0078]-[0080]; *Fresenius USA Inc. v. Baxter Int’l, Inc.*, 582 F.3d 1288, 1301-02 (Fed. Cir. 2009); *Sound View Innovations, LLC v. Hulu, LLC*, 818 Fed. App’x 1009, 1012-13 (Fed. Cir. 2020); Peterson, [165]-[172].

Weese encourages using multiple methods to “increase the information content of images containing motion artifacts” when combining images. Weese, Abstract, ¶¶[0004], [0013]-[0029], [0075]-[0084], Figs. 1-3; §VII.A; Peterson, [166]-[167]. Figure 1’s registration within Figure 2 would have been predictable. Weese, ¶¶[0077]-[0080], Figs. 1-2; Peterson, [168]-[172]. This forms a “sharper PET image” at the CT image’s motion state before combining images, facilitating comparison. Weese, ¶¶[0018], [0022]-[0035], [0047]-[0085], Figs. 1-4, claim 8; §VII.A; Peterson, [165]-[172].

## **B. Claim 1**

Claim 1 is obvious over Weese.

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

Weese discloses [1p].

Weese addresses motion artifacts in CT-PET combinations. Weese, ¶¶[0009], [0047]-[0084], Figs. 1-5; §VII.A. Patients and their organs (objects) “unavoidab[ly]” move during imaging. Weese, Abstract, ¶¶[0001]-[0018], Figs. 1-3, 6; §VII.A. Sensors collect a “motion signal” used to process images **I0**, **IS**, **I2**, **I3**, **I4**, **I5**, **I6**, **I7**, **I8**, **I9**, and **I10**. Weese, Abstract, ¶¶[0002]-[0011], [0047]-[0084], Figs. 1-3; §VII.A. Each image is “of a moving object,” per [1p]. Peterson, [173]-[178].

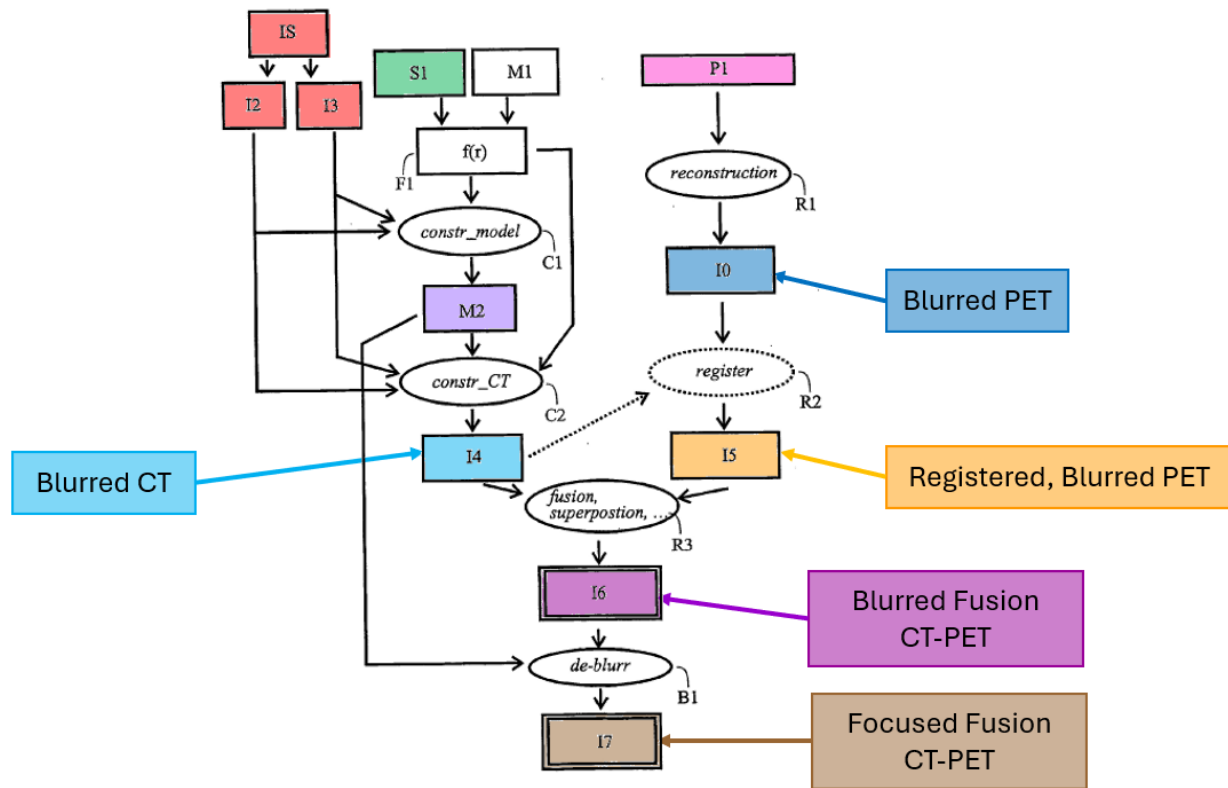


FIG.1

Weese, Fig. 1

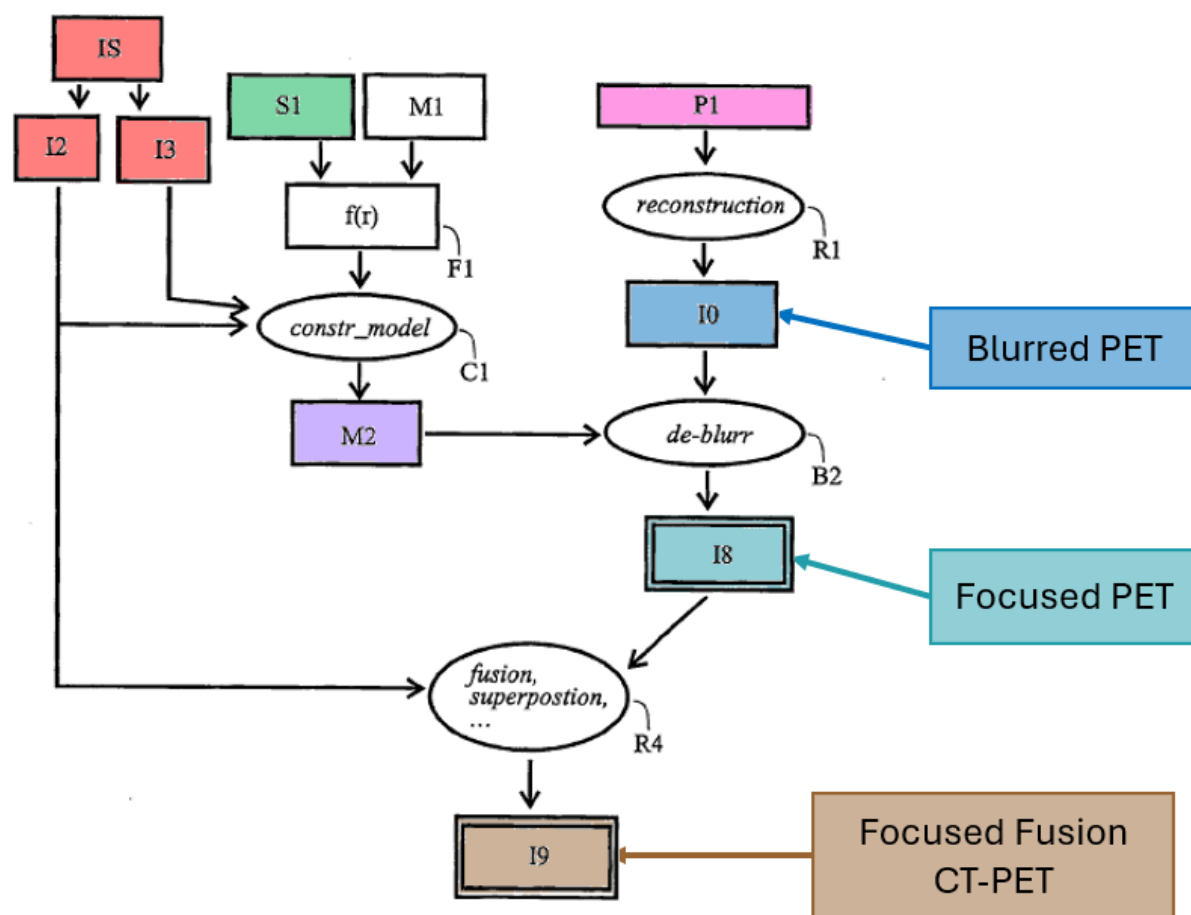
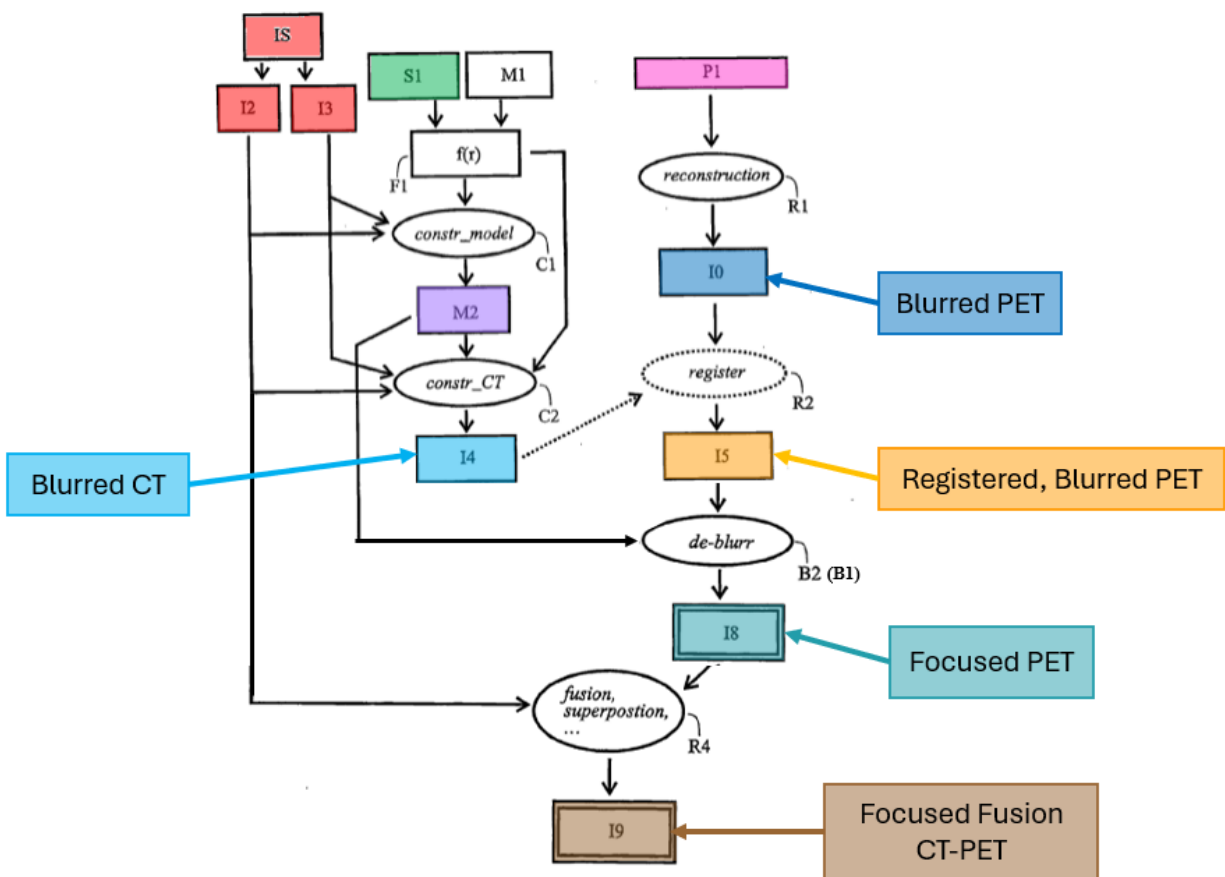


FIG.2

Weese, Fig. 2



Weese, modified Figs. 1-2

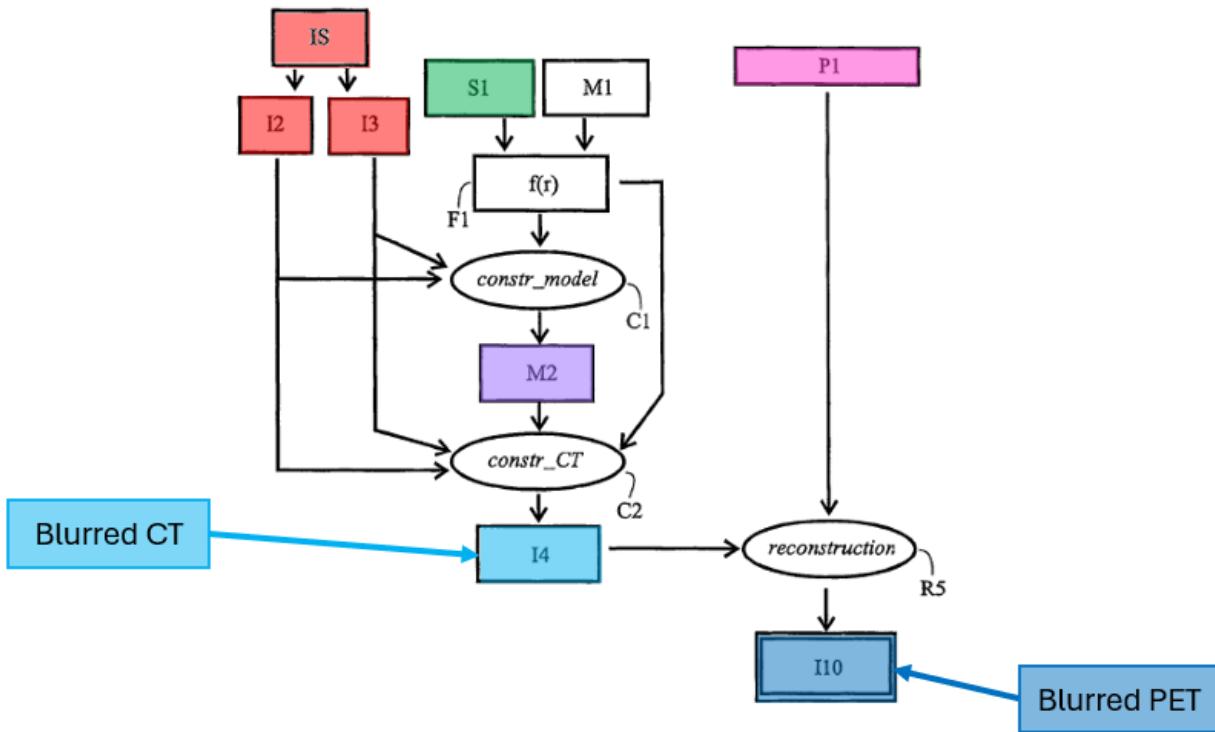


FIG.3

Weese, Fig. 3

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

Weese discloses [1a-i]. Peterson, [179]-[181].

Weese uses CT (“first imaging technique”) to acquire sequence **IS** and images **I2** and **I3** (“first images”). Weese, ¶¶[0002]-[0003], [0052]-[0084], Figs. 1-3. **I2** and **I3** represent different motion states (e.g., inhale or exhale) and may be “instantaneous images” or “extracted” from **IS**. Weese, ¶[0062].

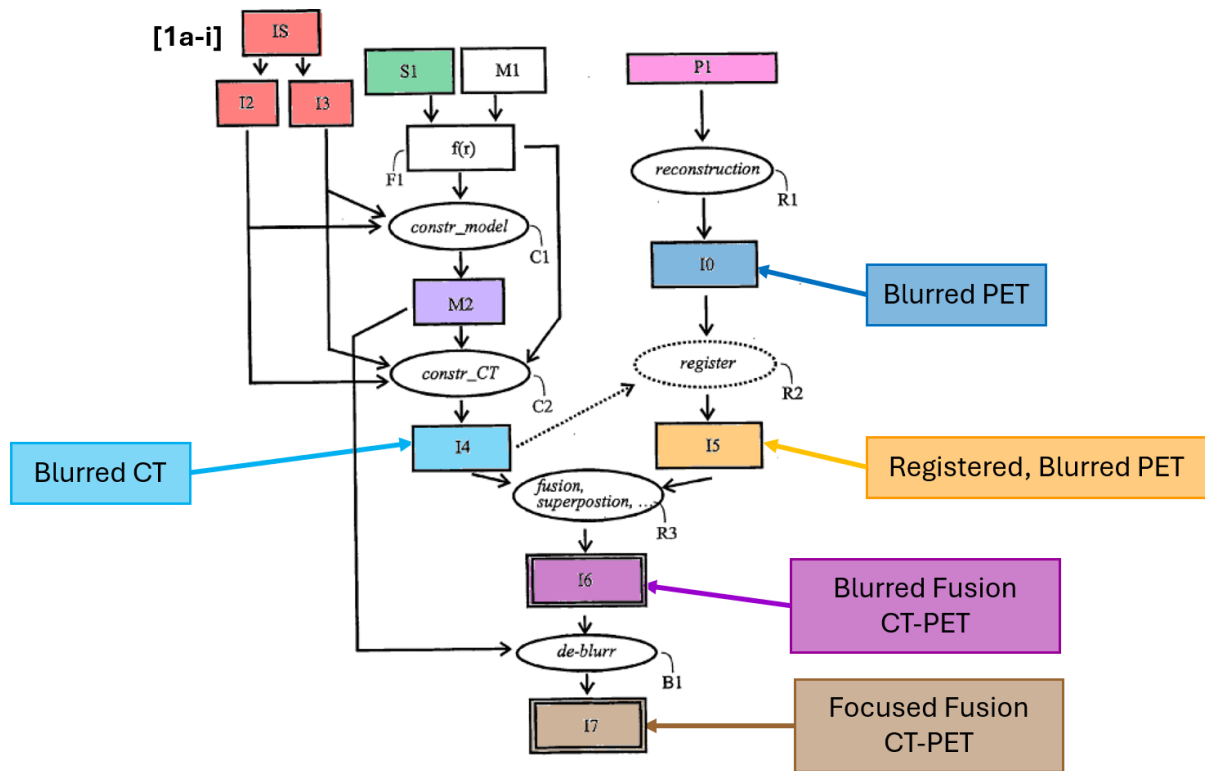


FIG.1

Weese, Fig. 1

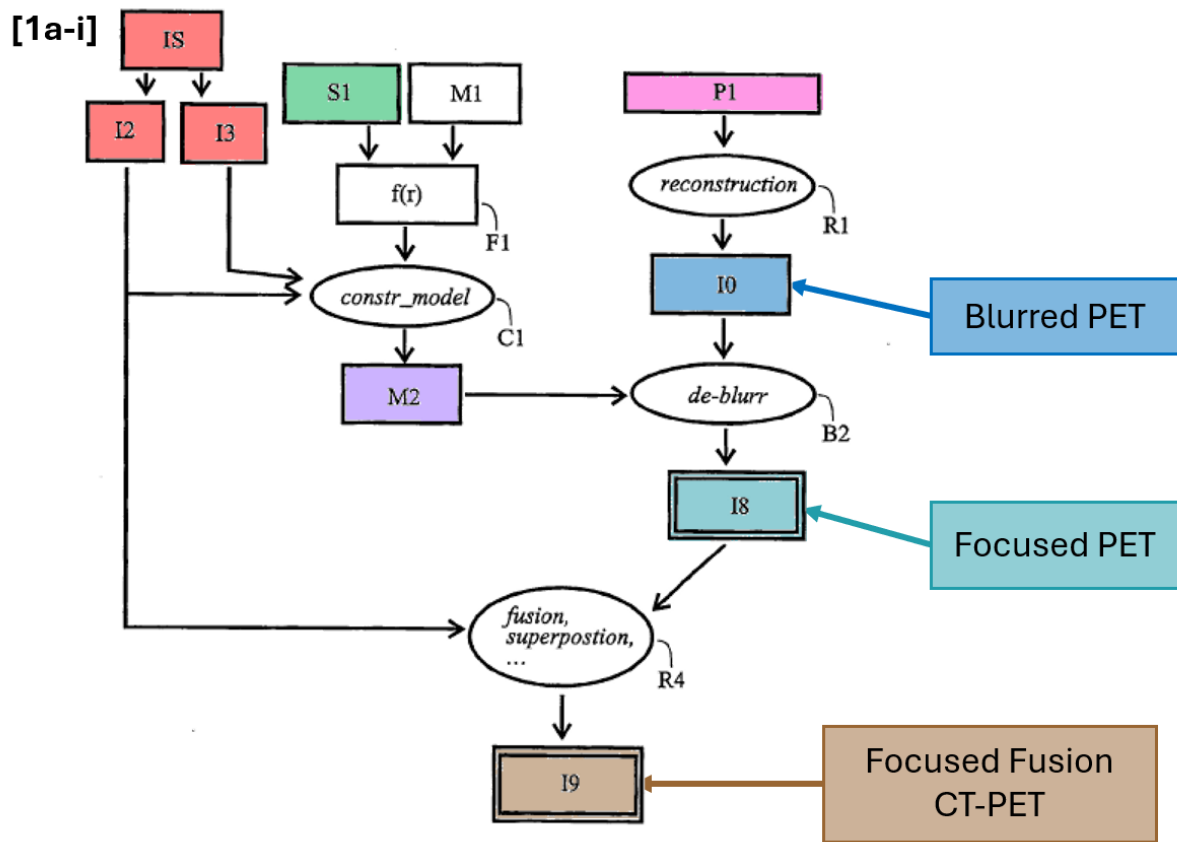
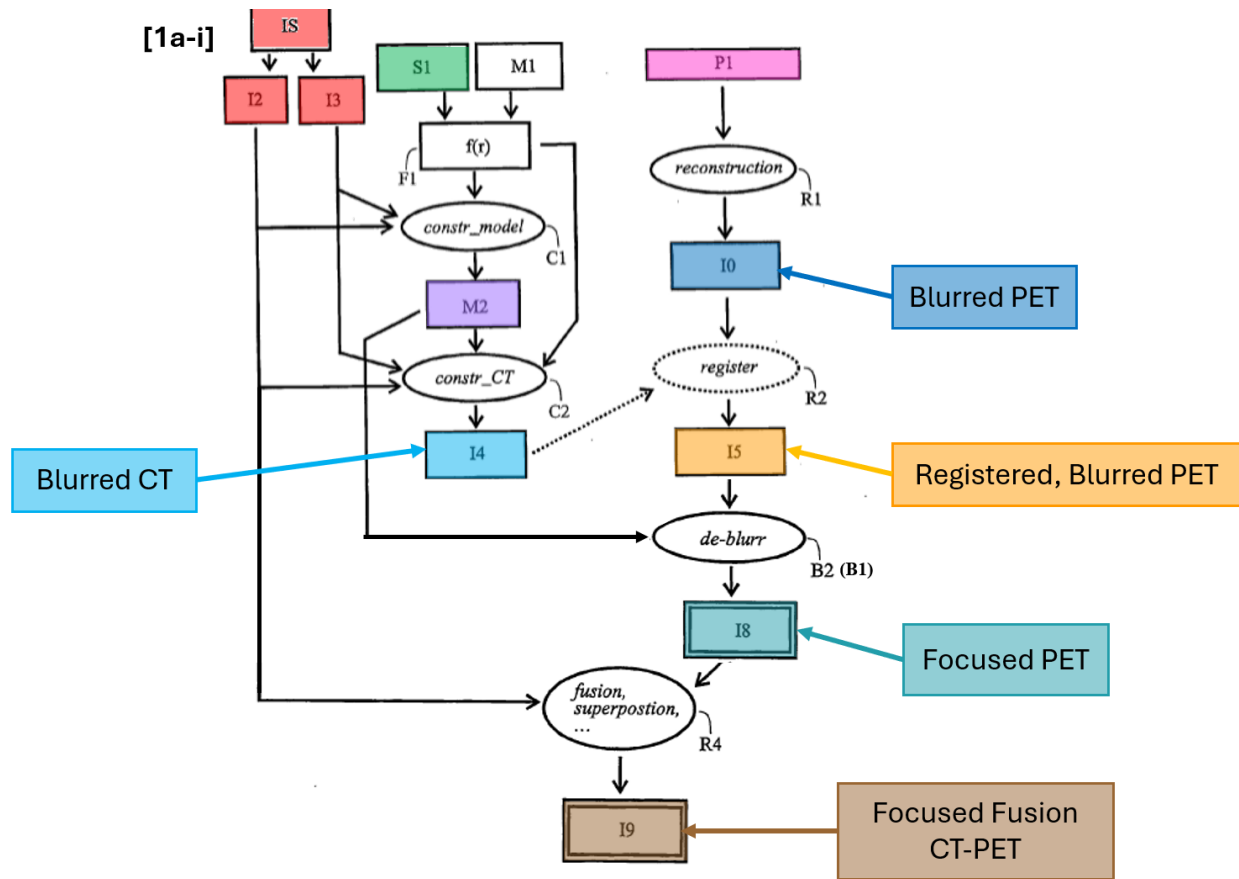


FIG.2

Weese, Fig. 2



Weese, modified Figs. 1-2

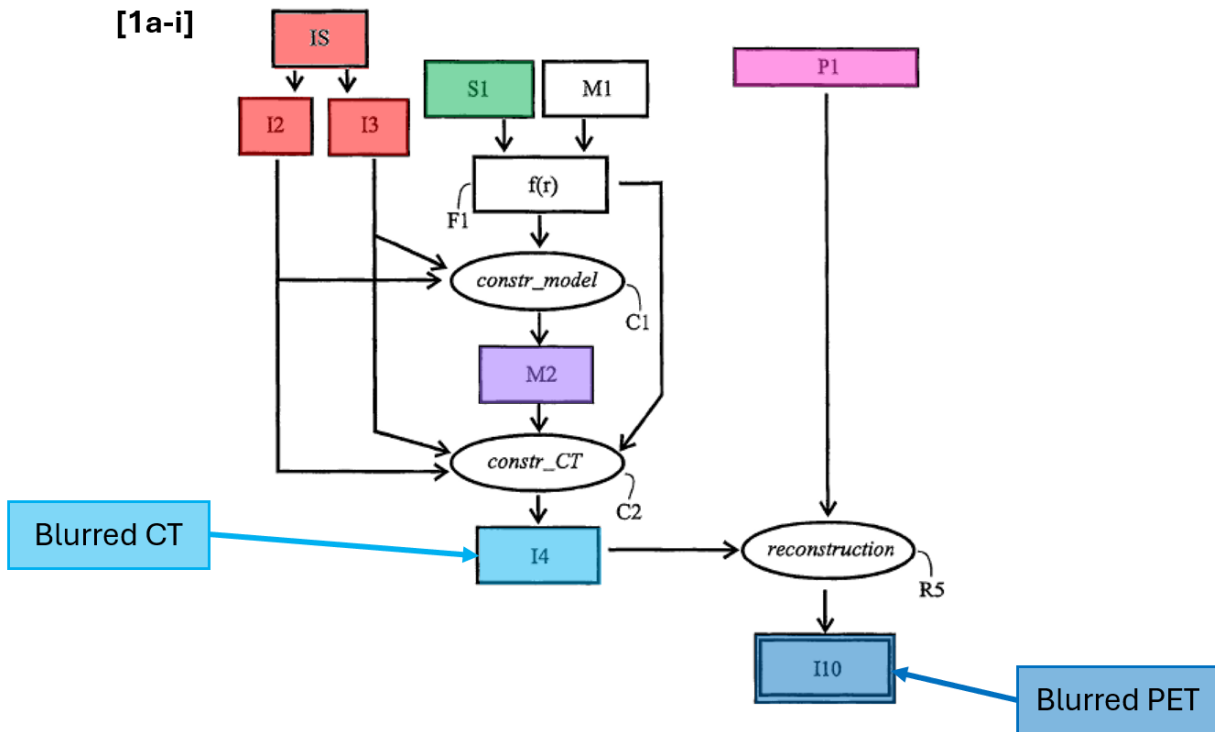


FIG.3

Weese, Fig. 3

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

Weese discloses and renders obvious [1a-ii].

**Motion sensor 15** (alone or with **acquisition unit 12**) is a “first sensor system” that provides a motion signal (corresponding “movements”), which discloses and renders obvious [1a-ii] in separate or combination CT-PET systems. Peterson, [183]-[189].

For combination CT-PET systems, **sensor 15** provides a “motion signal” to reconstruct CT images and extract **I2** and **I3** from **IS**. Weese, ¶¶[0031], [0053]-[0084], Figs. 1-6; §§VII.A. **Sensor 15** may be sensor **S1**. Weese, ¶¶[0031], [0062]-[0084], Figs. 1-3, 6; §§VII.A, VIII.A.

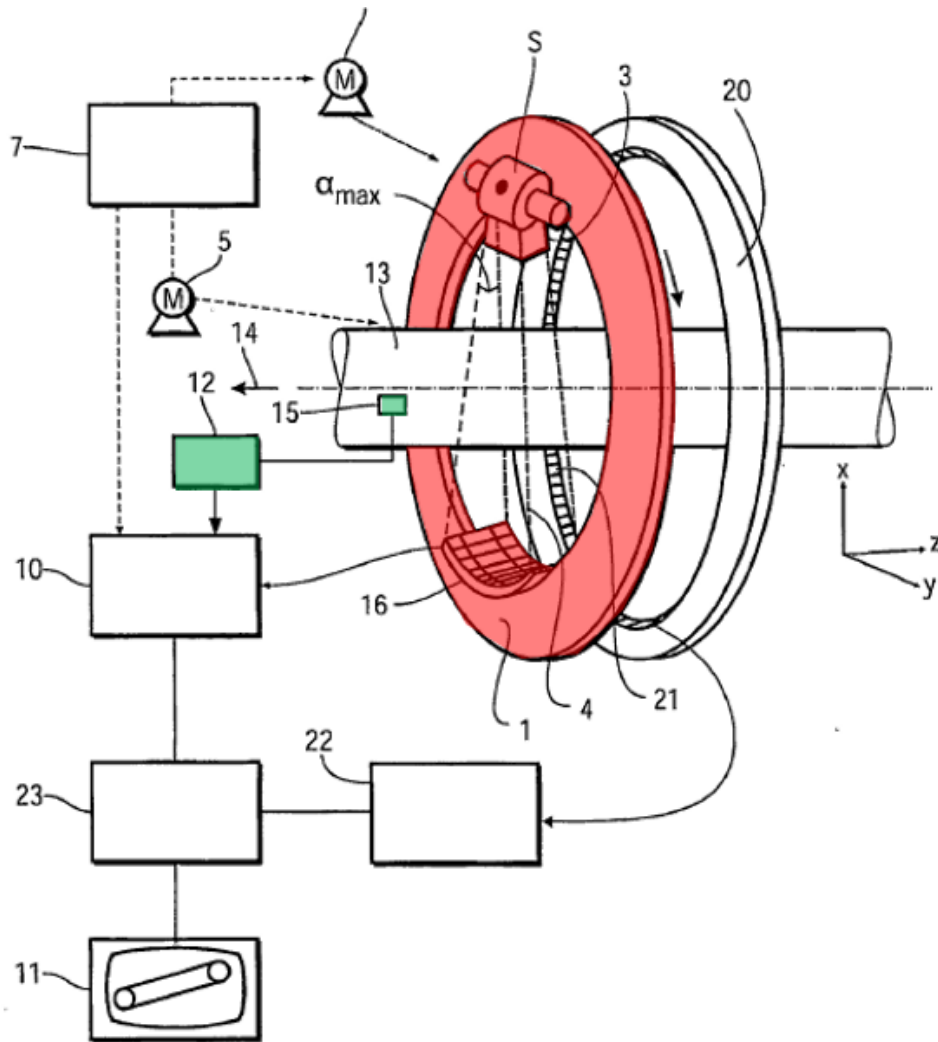


FIG.6

Weese, Fig. 6

For separate CT and PET systems, **sensor 15** and **S1** are different. Weese, ¶¶[0031], [0065]-[0080]; §§VII.A, VIII.A, VIII.B.3; Peterson, [187]-[189]. POSITAs would have used **sensor 15's** “actual motion” to match PET motion states and improve accuracy when extracting **I2** and **I3**. Weese, ¶¶[0031], [0057]-[0080]; Ex-1008, 735; Peterson, [188]; §§VII.A, VIII.A. This permits “natural respiratory motion” during CT that more “accurately corresponds” to PET acquisition. Peterson, [188]; Weese, ¶¶[0031], [0057]-[0080]; §§VII.A. Image comparison improves when “images exhibit substantially the same motion artifacts.” Weese, ¶[0075]; §VII.A.

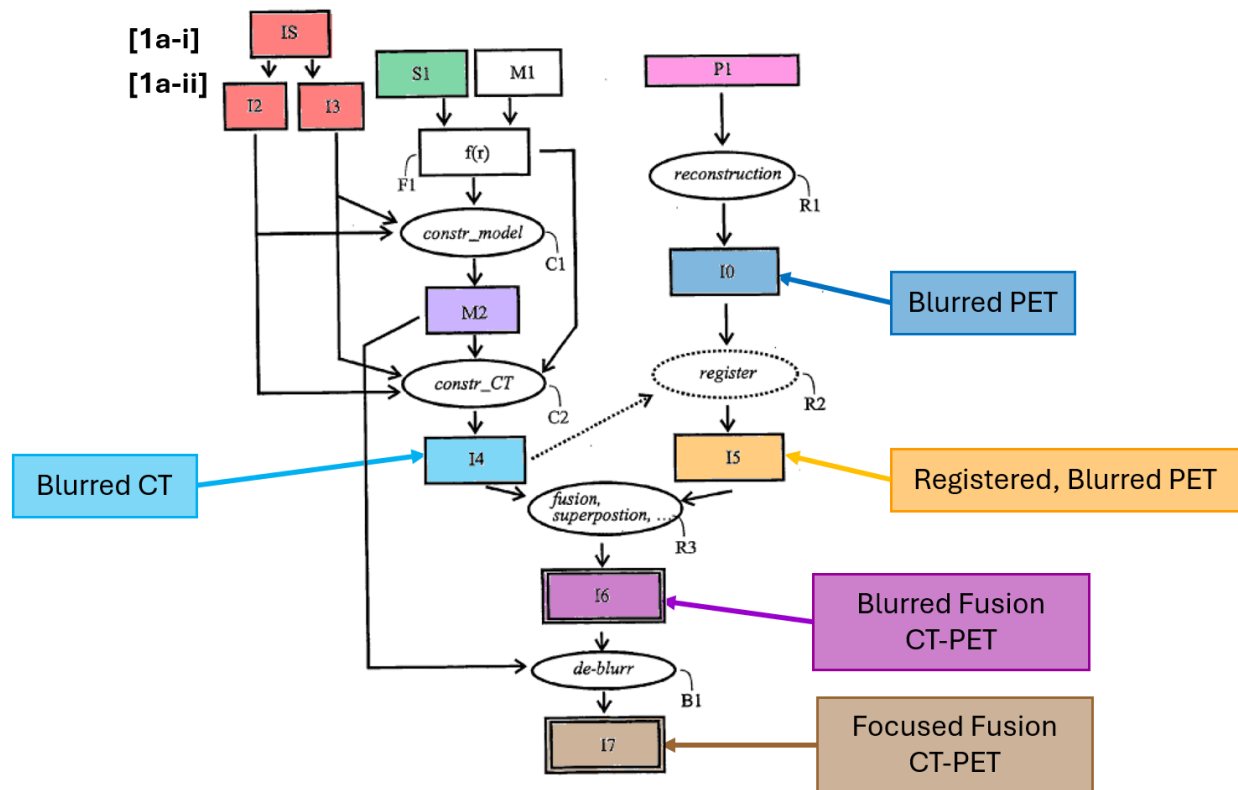
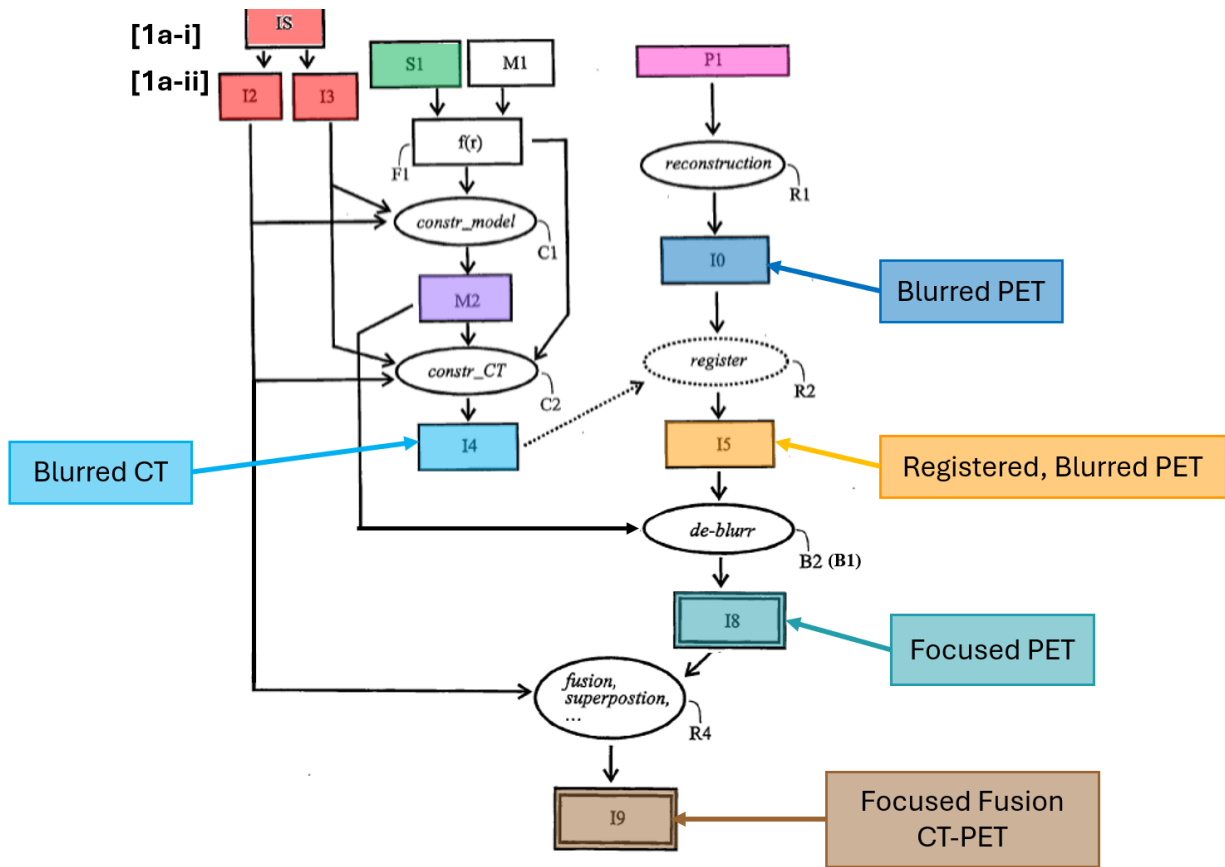


FIG.1

Weese, Fig. 1





Weese, modified Figs. 1-2

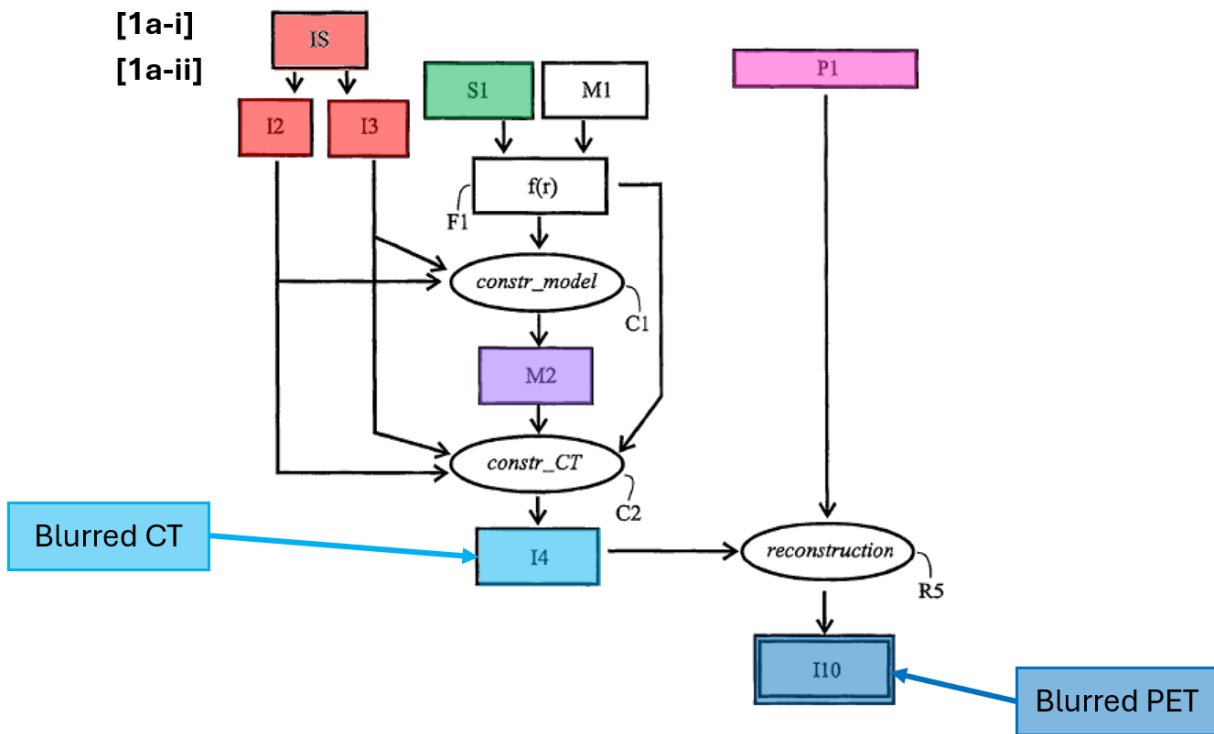


FIG.3

Weese, Fig. 3

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

Weese discloses [1a-iii].

**Sensor 15** monitors position independently from transmissions in combined and separated PET-CT systems. Weese, ¶¶[0031], [0053]-[0080]; Peterson, [190]-[193]; §§VII.A, VIII.A, VIII.B.3.

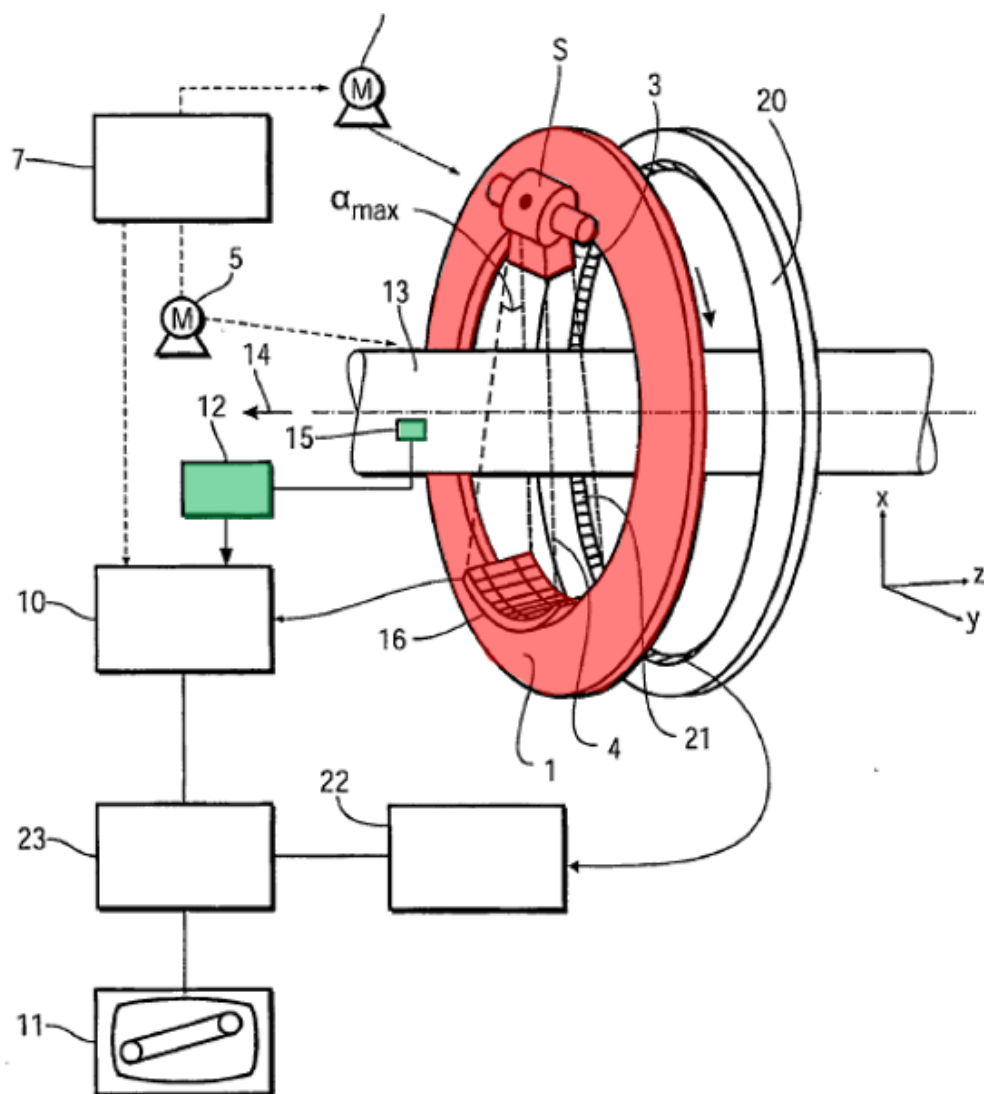
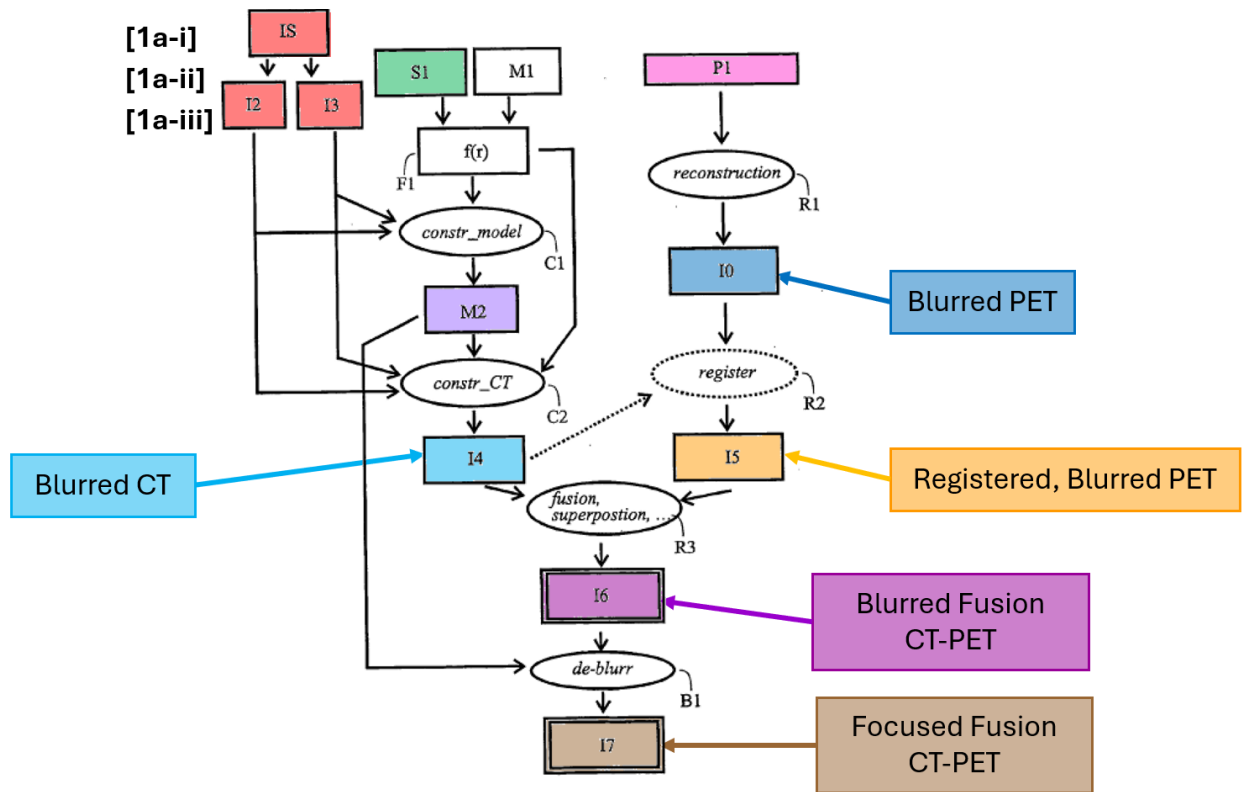


FIG.6

Weese, Fig. 6



Weese, Fig. 1

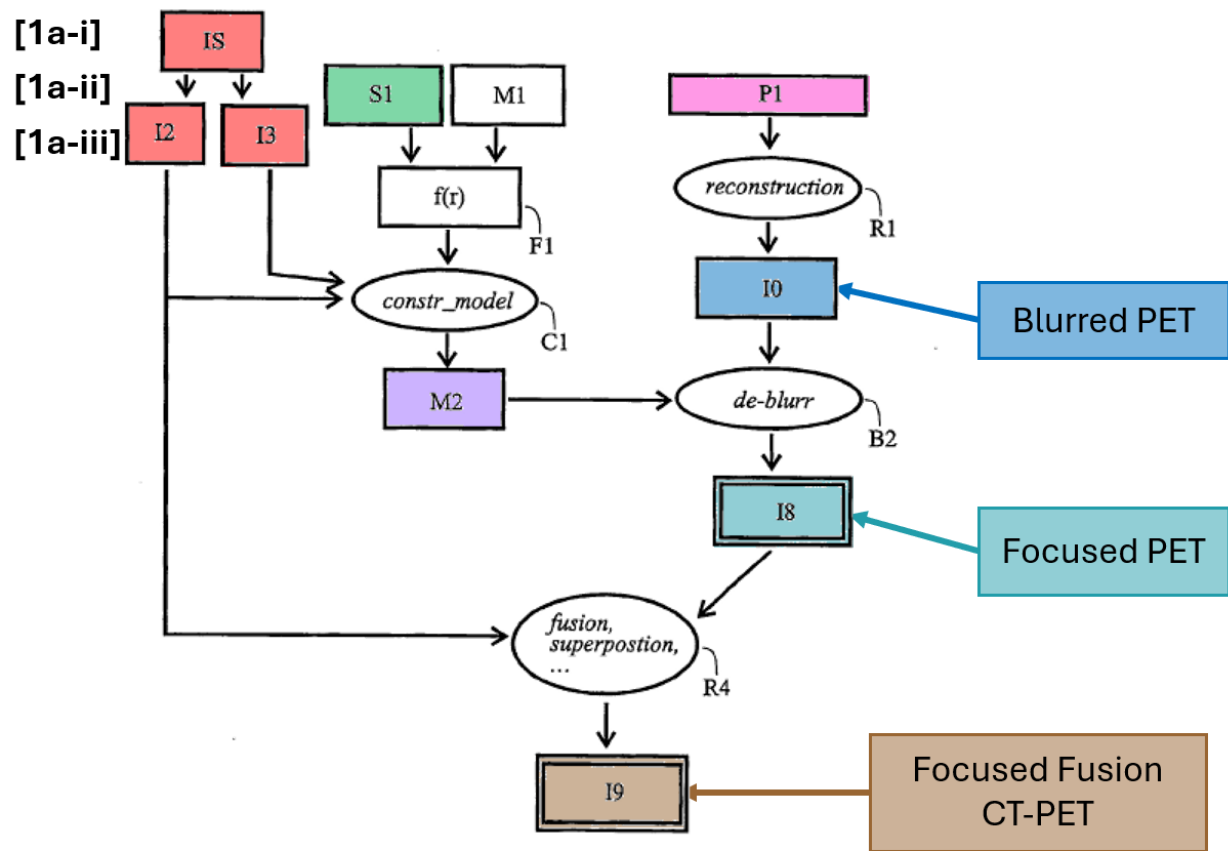
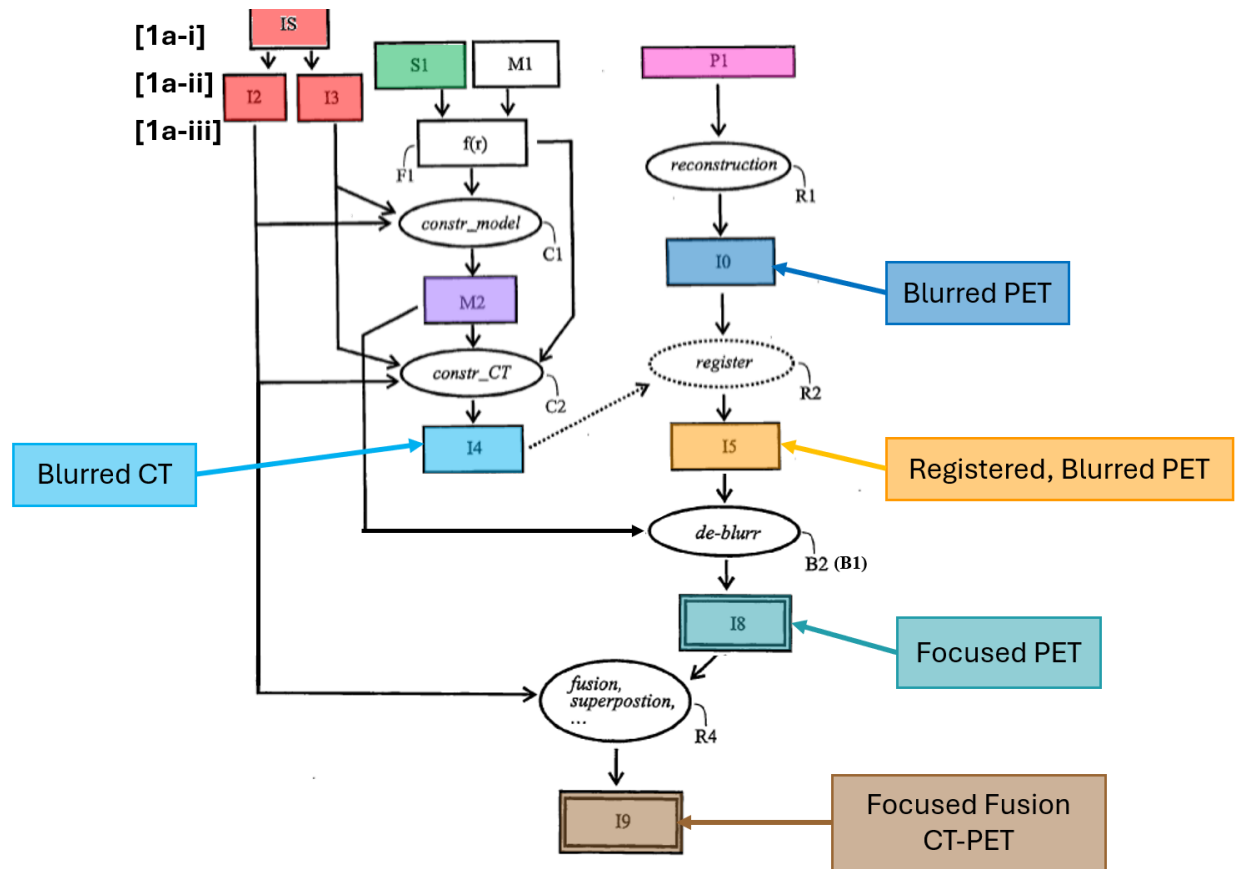


FIG.2

Weese, Fig. 2



Weese, modified Figs. 1-2

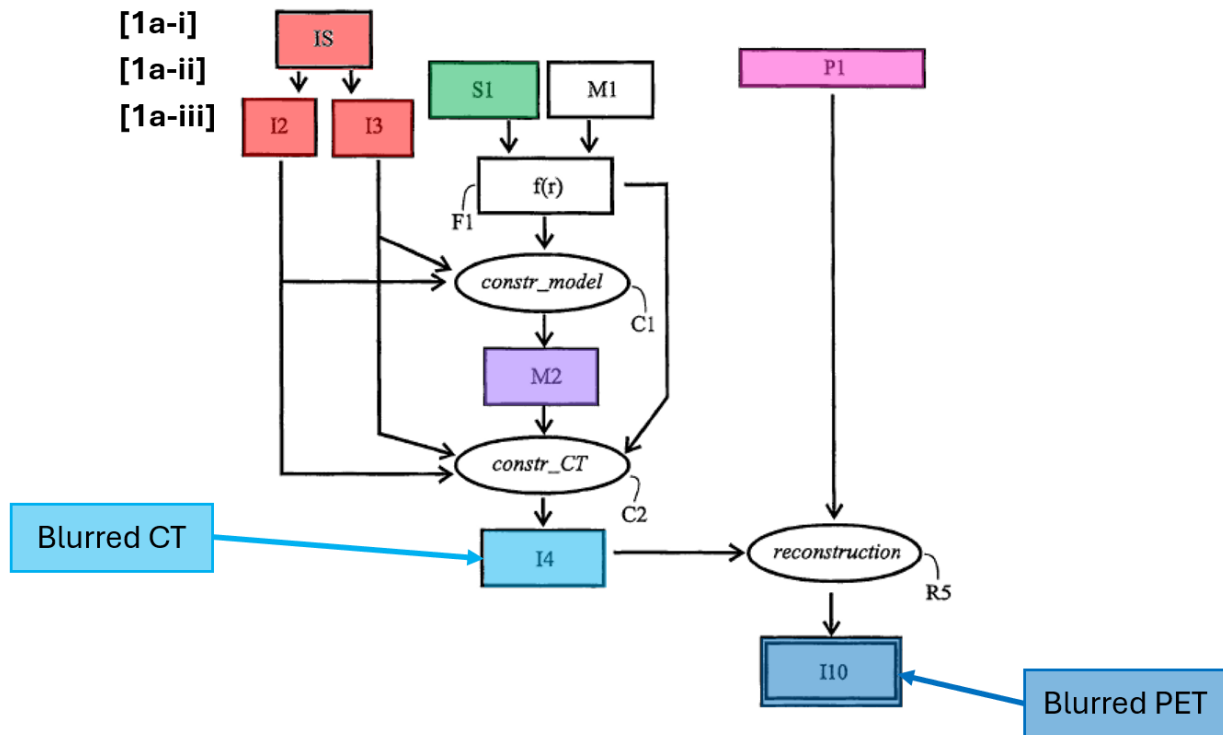


FIG.3

Weese, Fig. 3

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;

Weese discloses [1b].

**Sensor 15's** “motion signal” facilitates CT reconstruction. Weese, ¶¶[0055], [0057]; Peterson, [195]. The motion signal helps extract **I2** and **I3** from **IS** at specific states, thereby associating “first movement states” with “first images.” Weese, ¶¶[0010], [0053]-[0079]; §VIII.B.3; Peterson, [194]-[196]; §§VII.A, VIII.A.

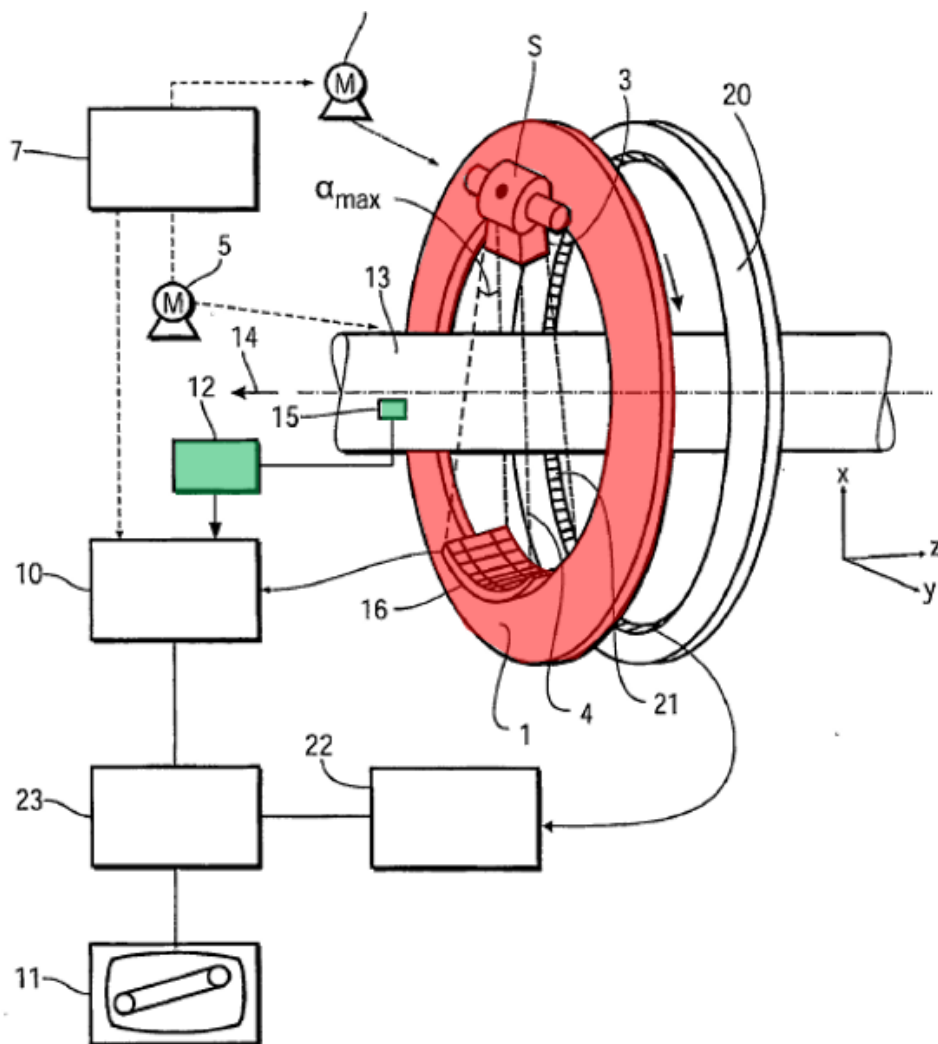
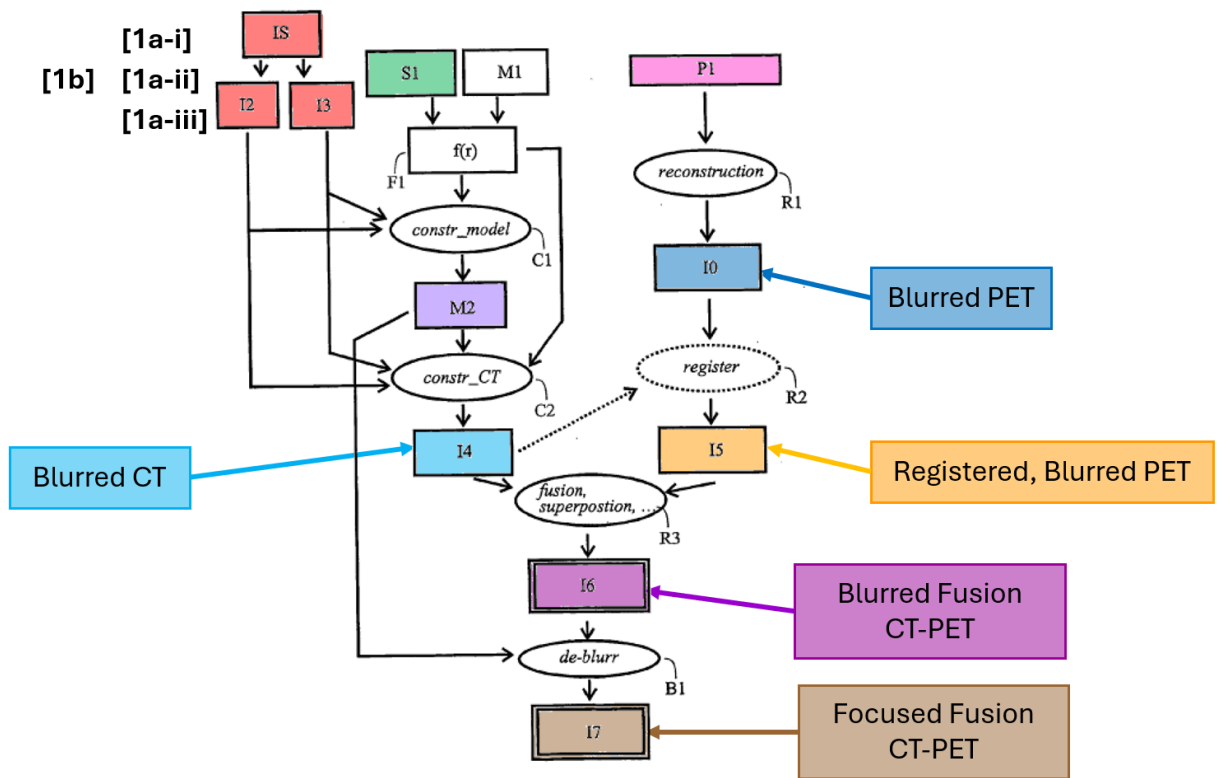


FIG.6

Weese, Fig. 6



Weese, Fig. 1

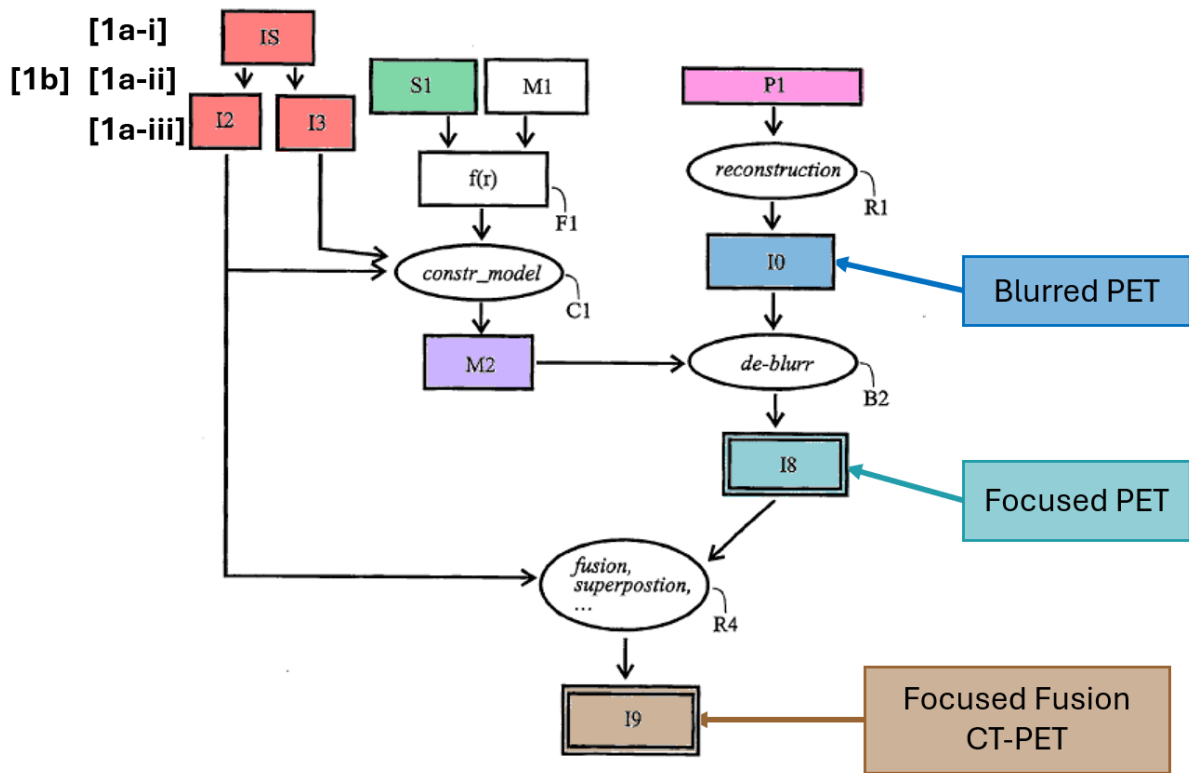
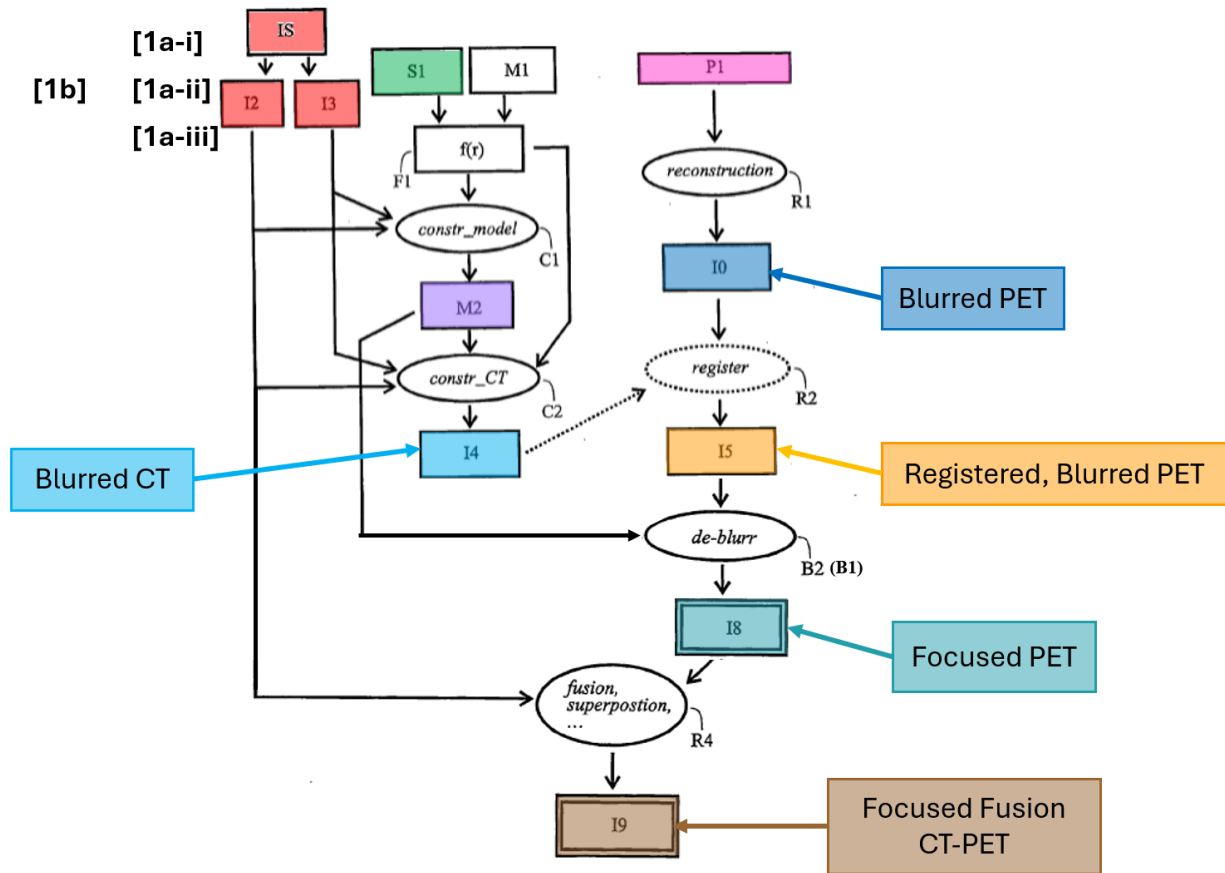


FIG.2

Weese, Fig. 2



Weese, modified Figs. 1-2

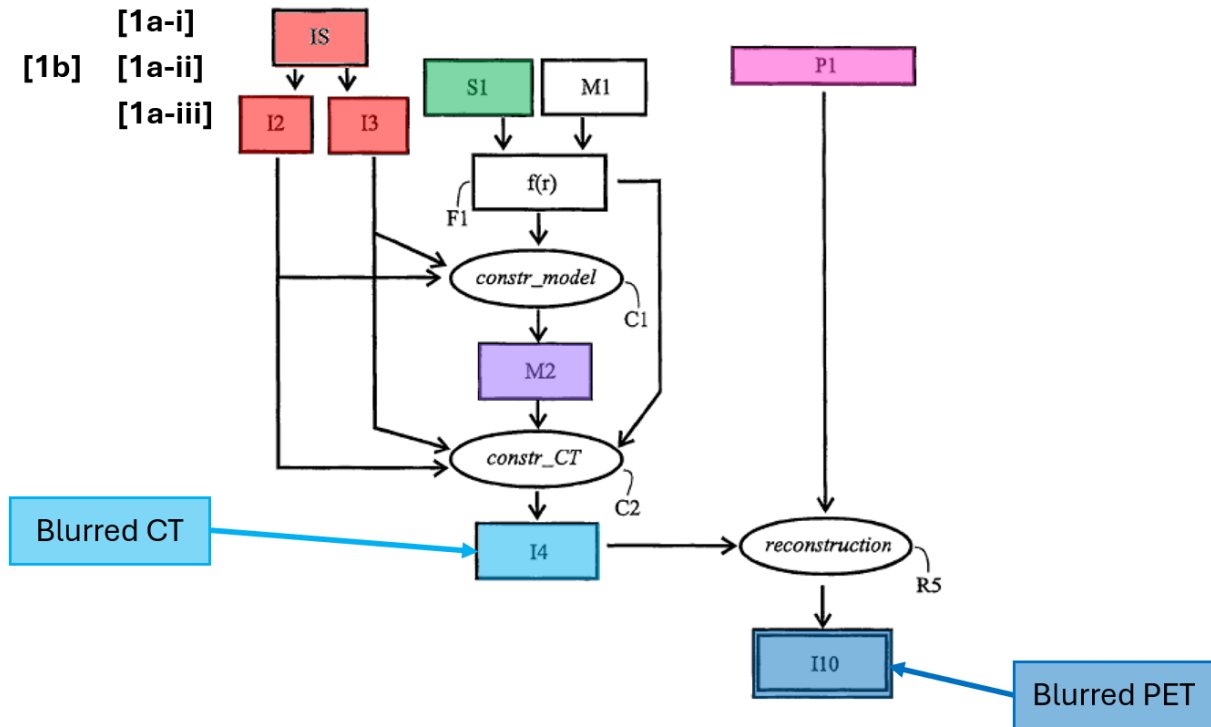


FIG.3

Weese, Fig. 3

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

Weese discloses and renders obvious [1c-i].

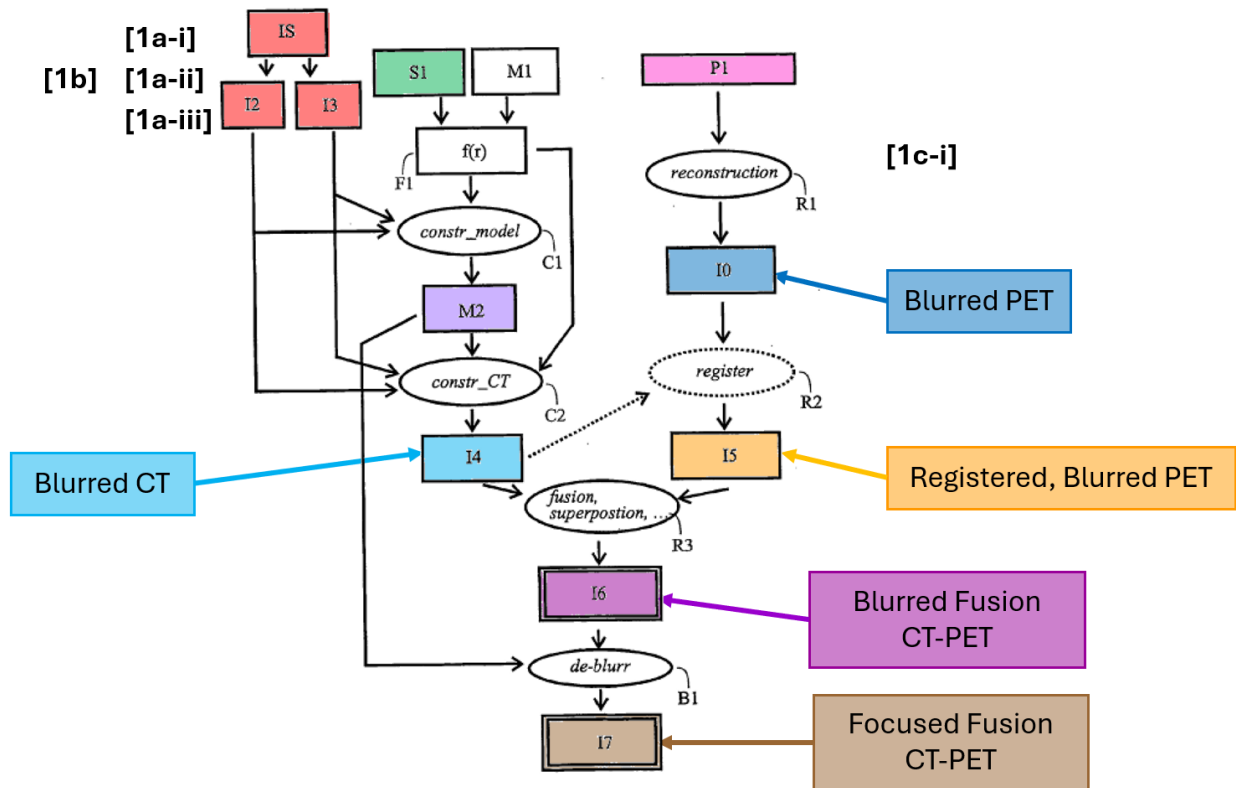
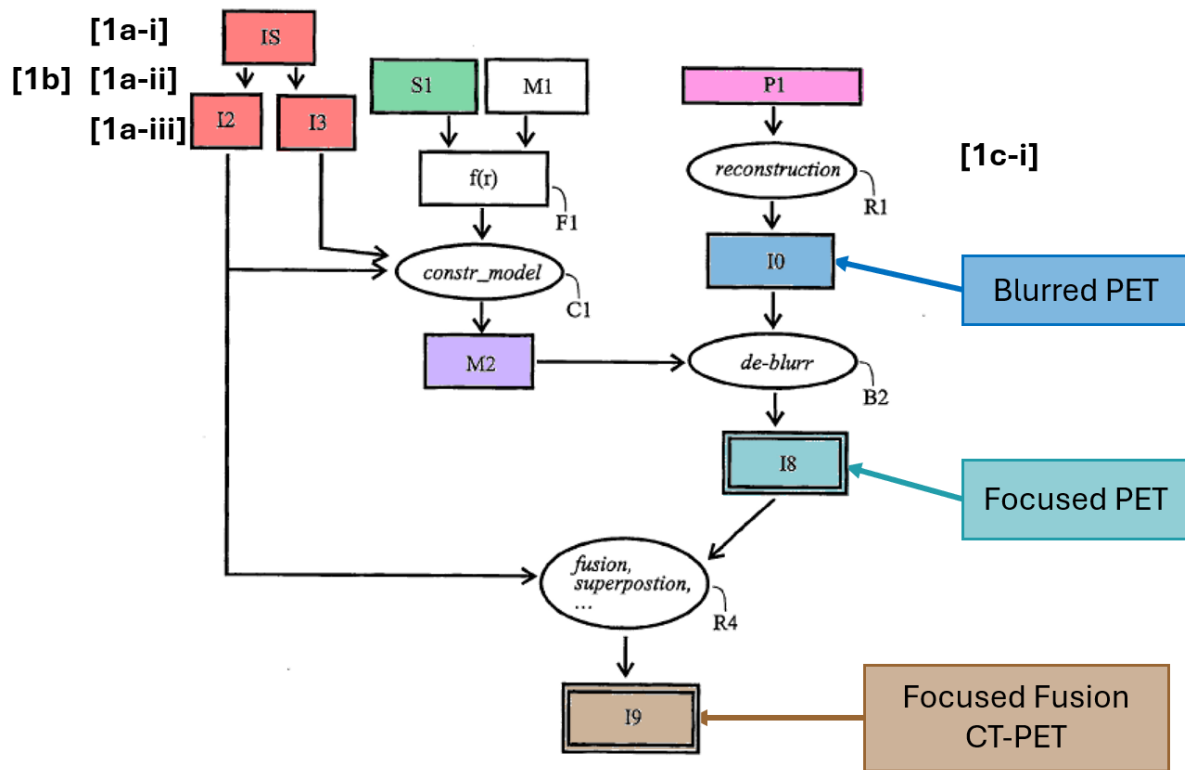


FIG.1

Weese, Fig. 1



Weese, Fig. 2



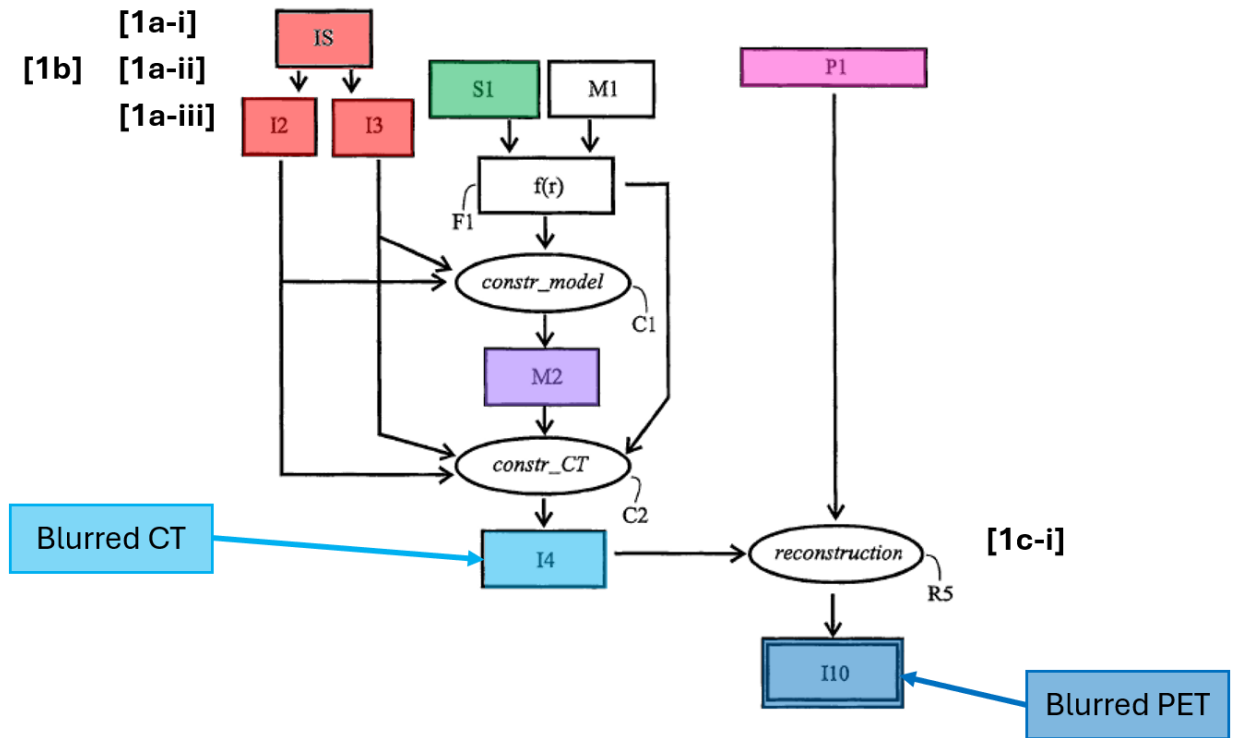


FIG.3

Weese, Fig. 3

Weese collects and reconstructs PET projections **P1** to create **I0** or **I10**. Weese, ¶¶[0047]-[0084], Figs. 1-3. PET is a “second imaging technique.” **I0** and **I10** disclose and render obvious a “plurality of second images” in two ways. Peterson, [197]-[211].

- a. **I0** and **I10** disclose and render obvious “a plurality of second images” because they may be a slice-by-slice “volume image”

**I0** and **I10** may be “volume images” formed using “known” techniques. Weese, ¶¶[0002], [0026], [0048], [0058], [0061], [0084]. A volume image discloses

and renders obvious obtaining multiple slices because POSITAs were familiar with slice-by-slice volume rendering methods. Peterson, [197]-[207].

Muehllehner, Wainer, and other references describe slice-by-slice PET volume imaging, which is textbook volume rendering. Peterson, [204]; Muehllehner, Abstract, 1:65-2:14, 12:48-60, 13:18-38, Figs. 2, 2a, 11-13; Wainer, 6:53-60; Ex-1019, Abstract, 2:18-33, 5:61-6:4, 6:11-25, 10:60-62, 16:62-67, Fig. 2. Slice-by-slice was the sort of suitable “known” volume imaging method Weese references. Peterson, [203]-[206].

Slice-by-slice rendering would have had predictable success to create 3D images because it uses the same hardware as Weese—a radiation source, gantry, and computers for collecting slices and reconstructing PET images. Weese, ¶¶[0047]-[0058], Fig. 6; Muehllehner, 3:27-58, Fig. 1; Peterson, [205]-[206]. *Fresenius*, 582 F.3d at 1301-02; *Kemco*, 208 F.3d at 1361.

Further, slice-by-slice PET volume approaches provided advantages over direct 3D acquisition, which suffered from scattering effects. Peterson, [207]. Weese’s PET volume images would have been slice-by-slice images in many instances. *Id.*

**b. Weese's image I0 and I10 disclose and render obvious obtaining "second images" because PET yields a "superposed ... image" of "several states of motion"**

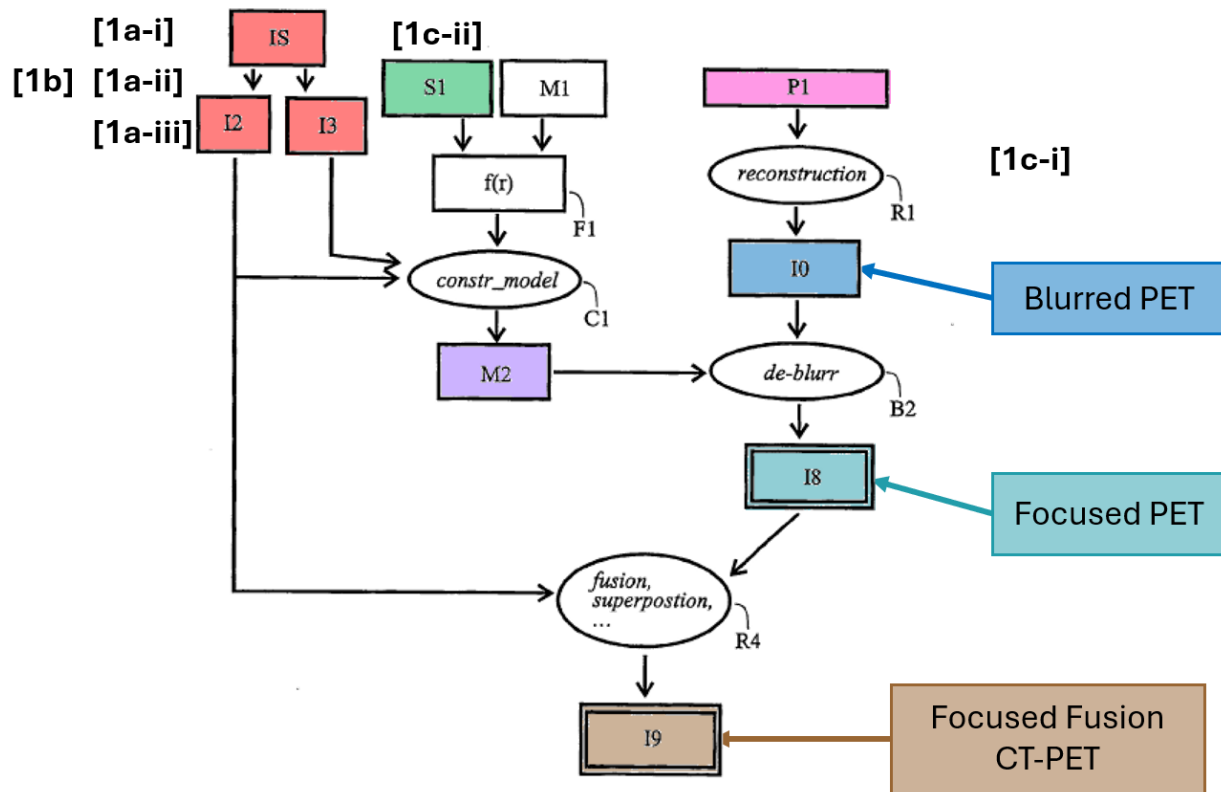
**I0** and **I10** are "superposed" PET images encompassing "several states of motion," which discloses and renders obvious "second images." Weese, ¶¶[0004]-[0008], [0022], [0037], [0047]-[0052], [0070], [0083], Figs. 1-3; §§VII.A, XII.A. POSITAs knew this concept. Peterson, [208]-[211]. A "PET image is *an integration* over the respiratory and cardiac cycles." Ex-1017, ¶[0109]. And well-known PET gating techniques relied on this concept. Peterson, [208]-[211]; §V. The '353 patent recognizes ordinary PET images are superposed. Ex-1001, 2:53-3:48, Fig. 1.

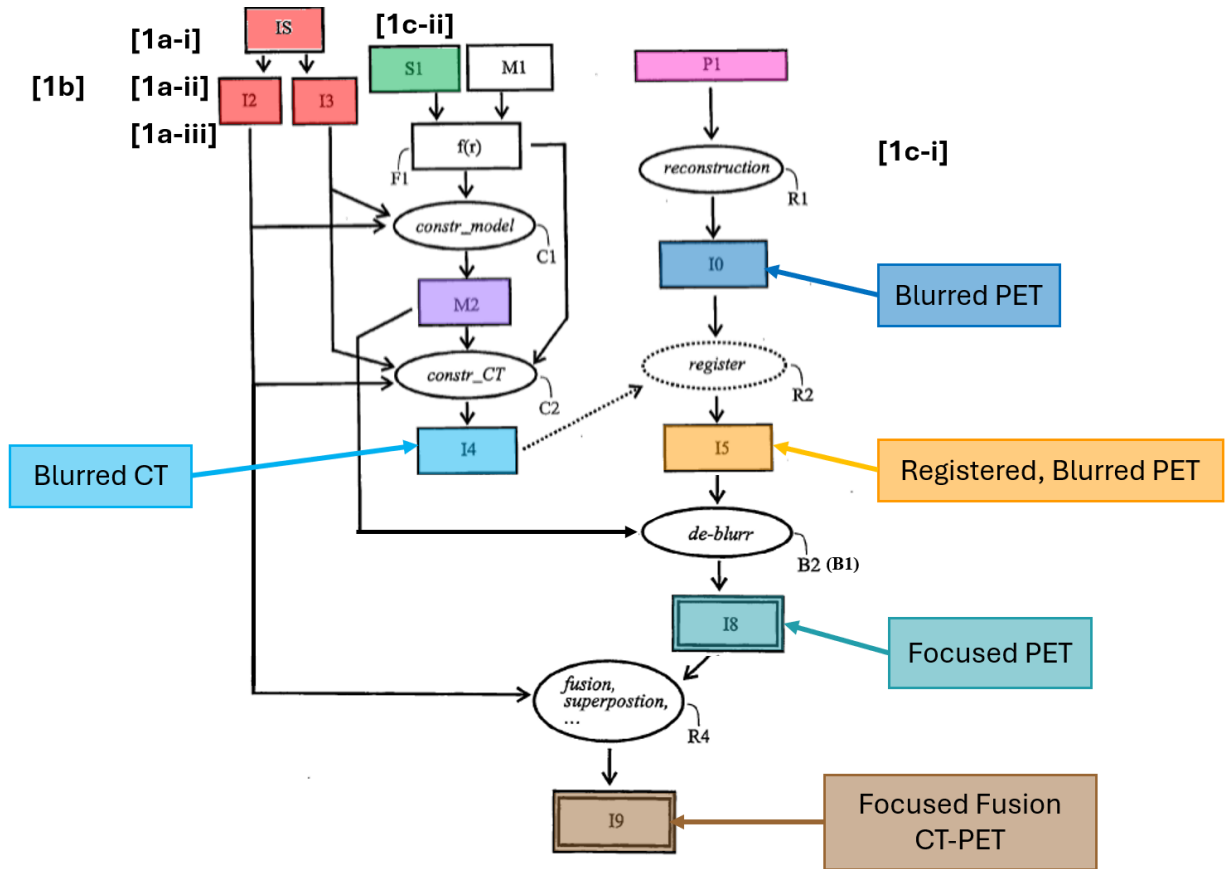
**7. [1c-ii] while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system**

Weese discloses and renders obvious [1c-i].

**S1** ("second sensor system") determines motion during PET acquisition, per [1c-i], whether **sensor 15** and **S1** are the same or different. Weese, ¶¶[0065]-[0083], Figs. 1-3; §§VII.A, VIII.A, VIII.B.3. In either combined or separated PET-CT systems, **S1** data contributes to **M2**, which desirably facilitates image comparison at common motion states. Weese, ¶¶[0031], [0057]-[0083], Figs. 1-3; Peterson, [212]-[216]; §§VII.A, VIII.A, VIII.B.3; Ex-1008, 735; Ex-1009, 1609-1610; Ex-1010.







Weese, modified Figs. 1-2

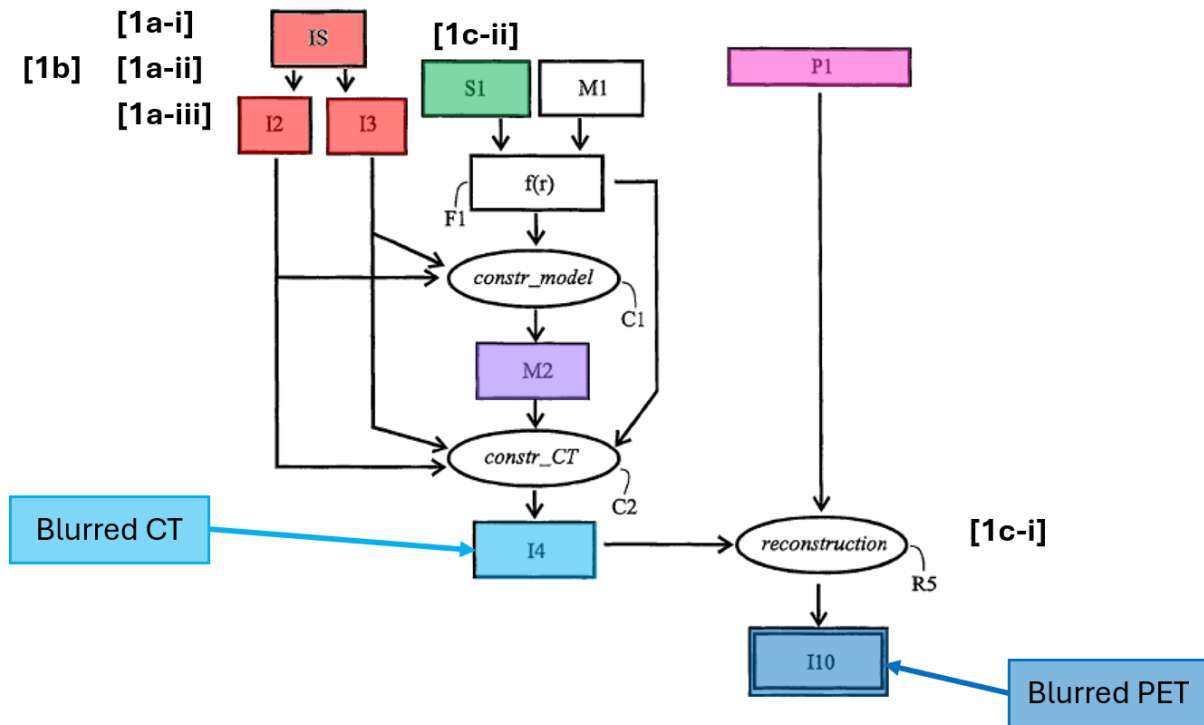


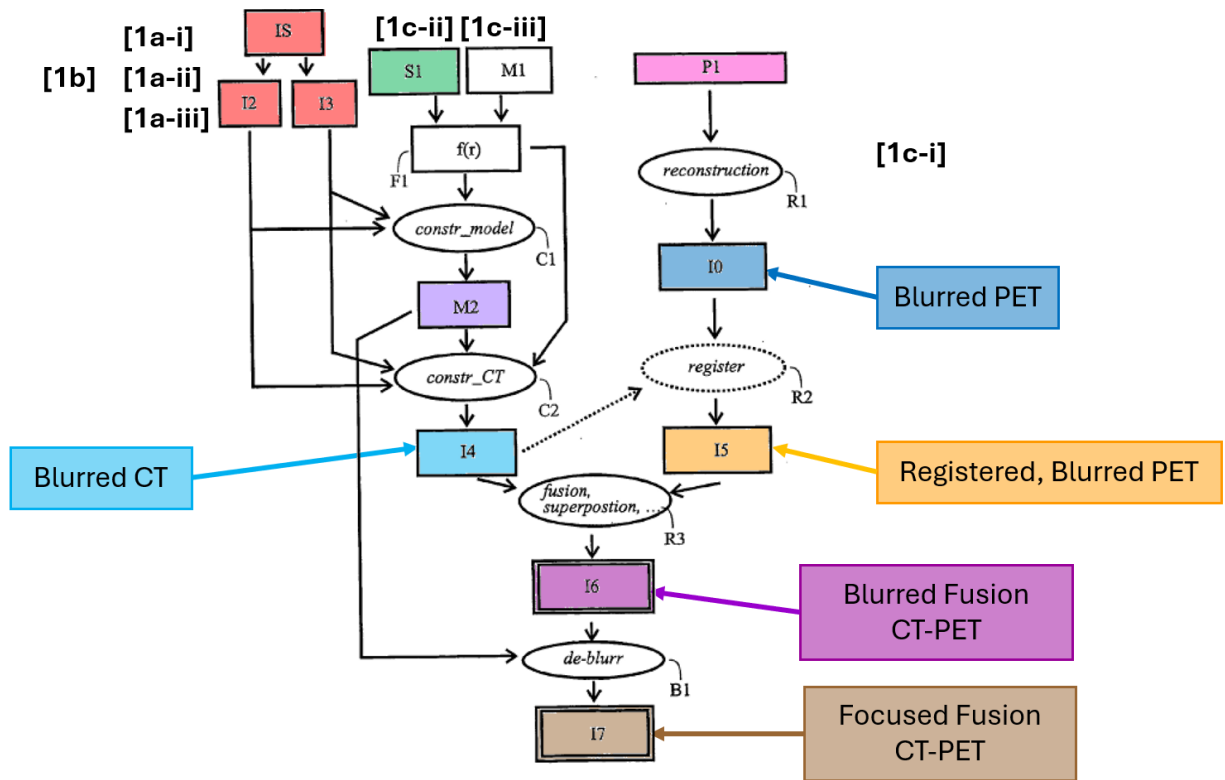
FIG.3

Weese, Fig. 3

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

Weese discloses [1c-iii].

**S1** monitors position independently from PET emissions in combined and separated PET-CT systems. Weese, ¶¶[0065]-[0080]; Peterson, [217]-[218]; §§VII.A, VIII.A; VIII.B.7.



Weese, Fig. 1

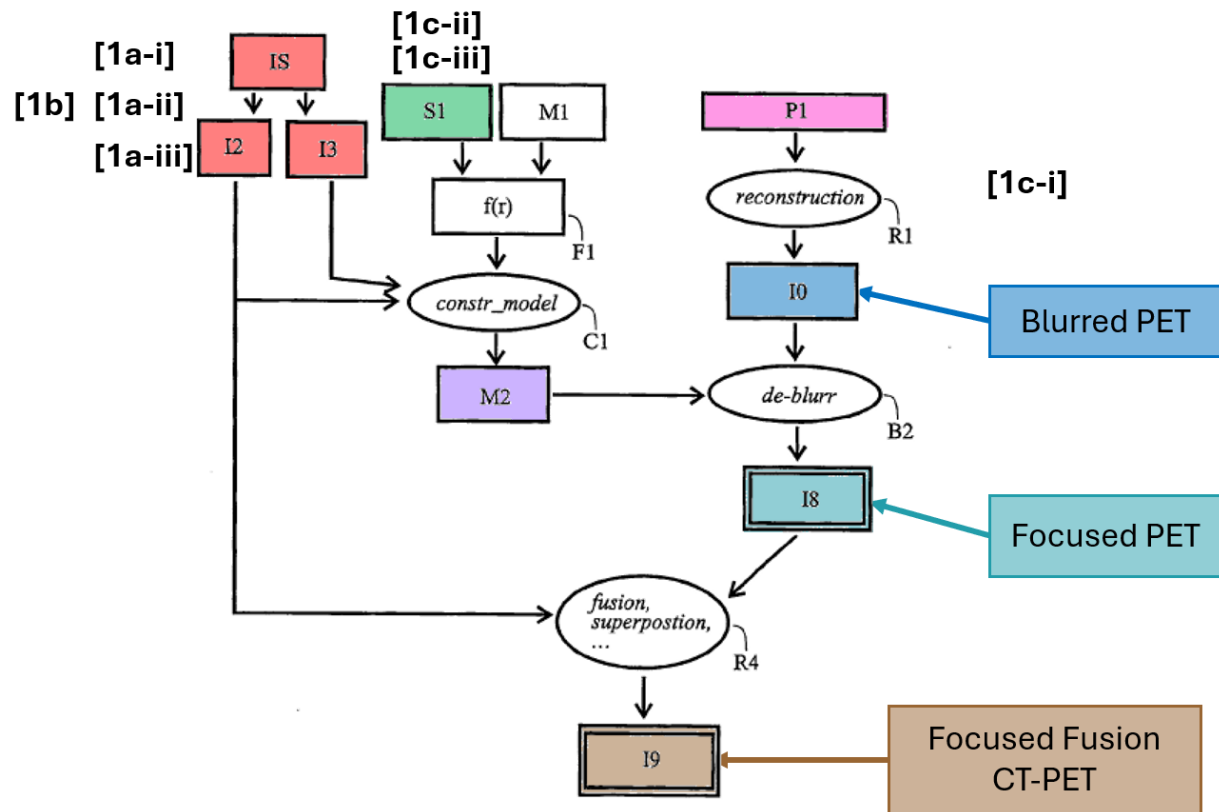
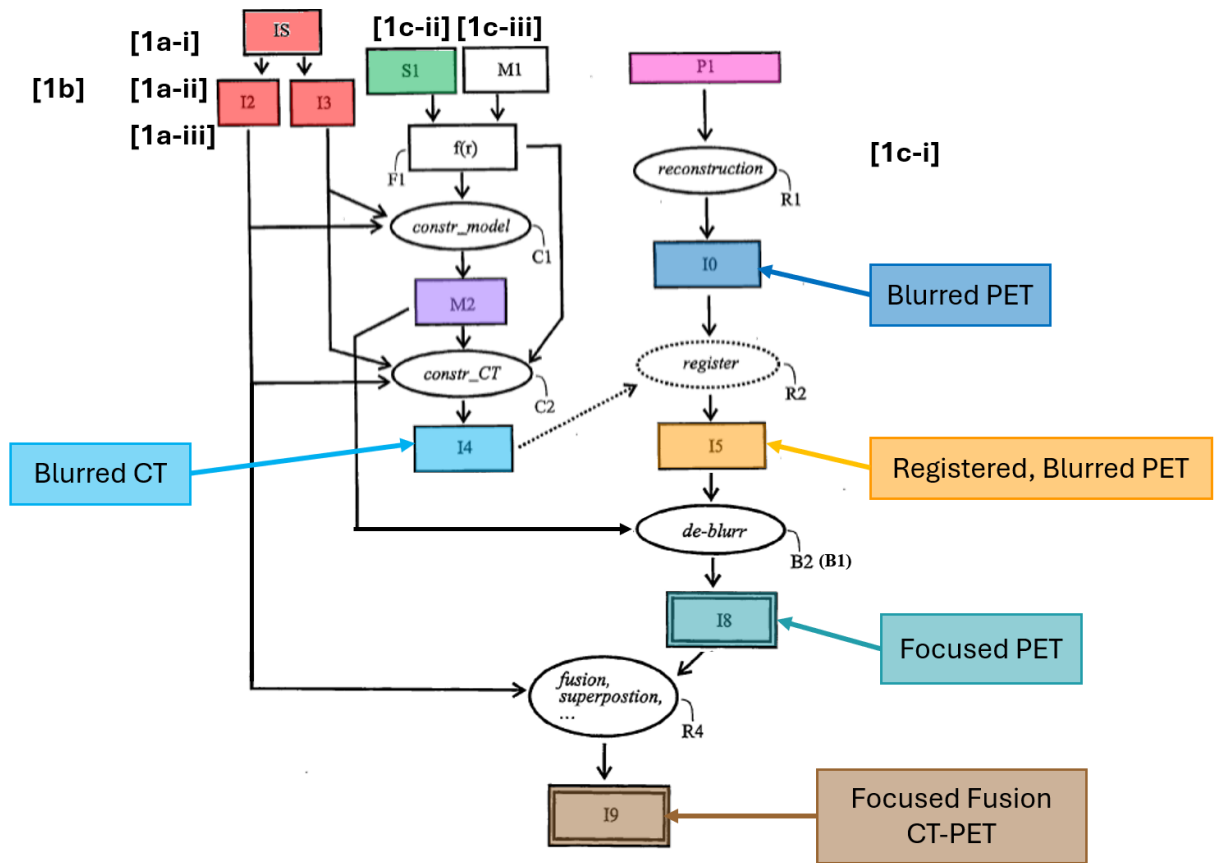


FIG.2

Weese, Fig. 2



Weese, Figs. 1-2

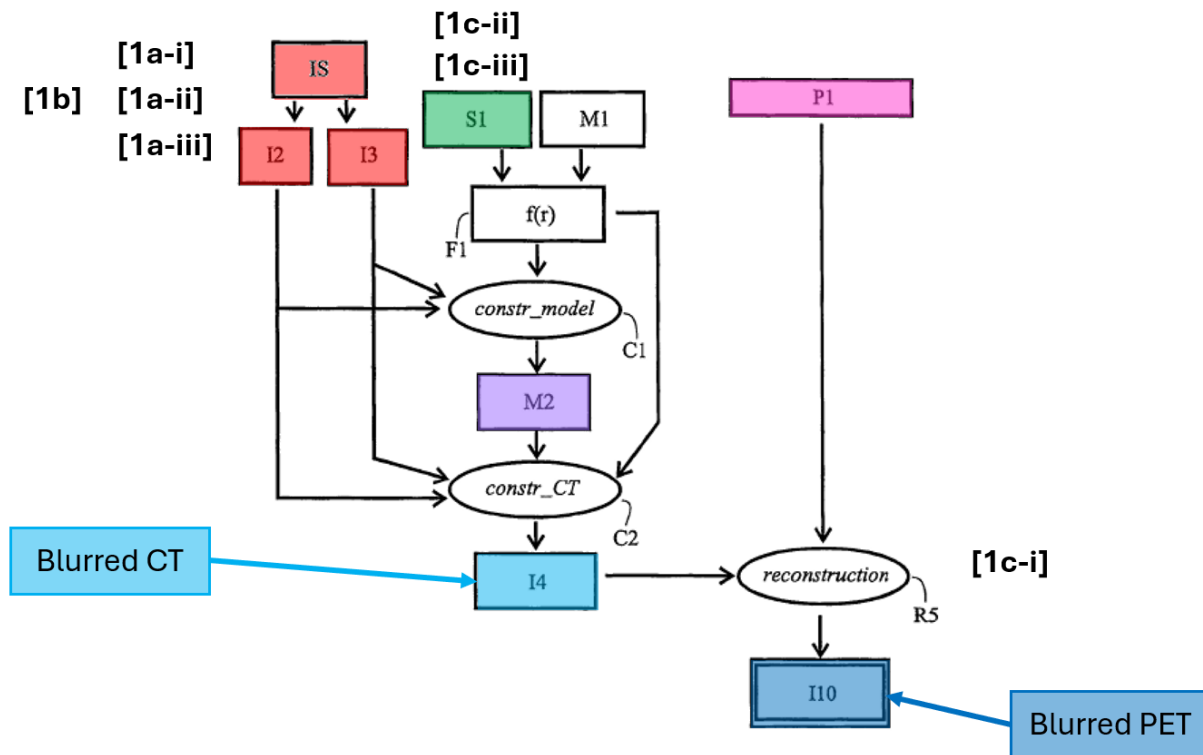


FIG.3

Weese, Fig. 3

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

Weese discloses and renders obvious [1d] *thirteen* ways. Peterson, [219]-[244].<sup>1</sup>

---

<sup>1</sup> The claim requires using *first* measurements, not second, when associating second images with second movement states. If Patent Owner argues “first” is a typo, the [12d] analysis demonstrates Weese discloses [1d]. § VIII.M.9; Peterson, [219].

Weese uses “state of motion function F1” to construct “**motion model M2**” based on **I2** and **I3**. Peterson, [220]; Weese, Abstract, ¶¶[0005]-[0020]-[0025], [0031]-[0033], [0057]-[0084], Figs. 1-3, 5, claims 1, 5. As explained in *three* steps, below, F1 and **M2** disclose and render obvious [1d]. Peterson, [220]-[221].

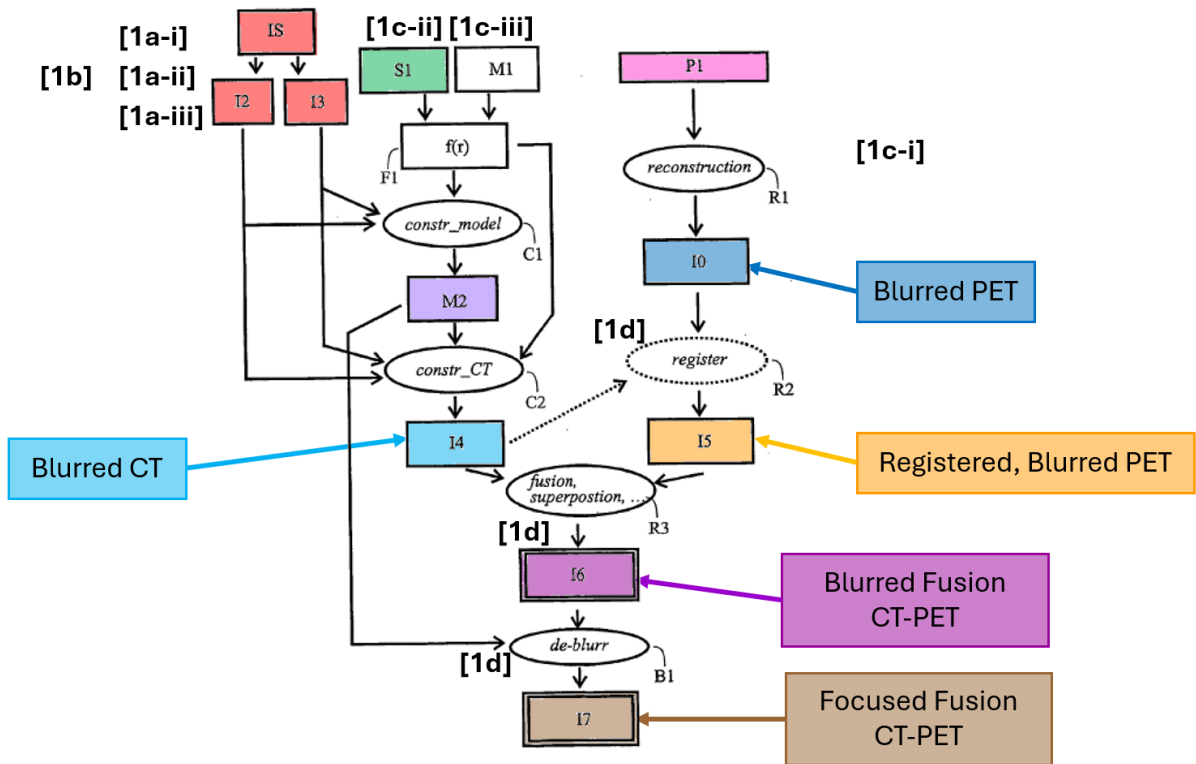


FIG.1

Weese, Fig. 1

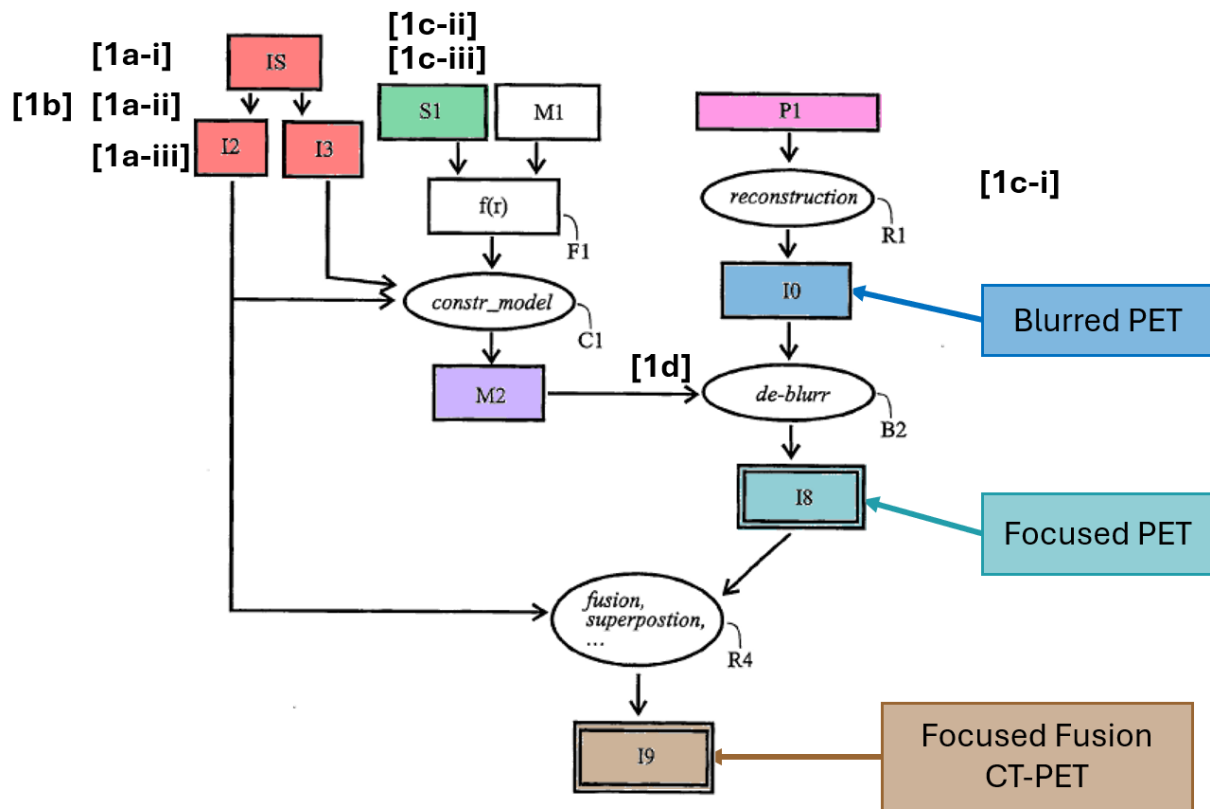
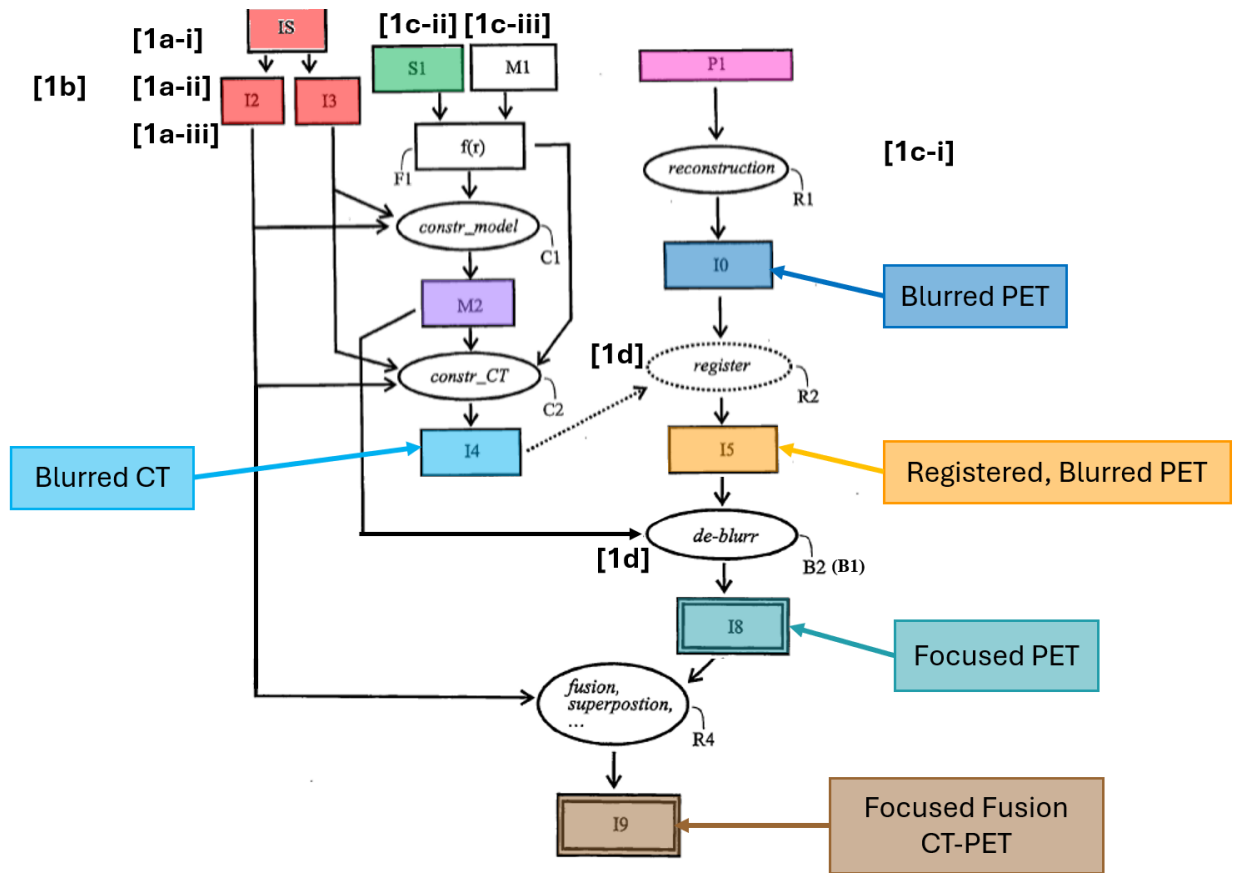


FIG.2

Weese, Fig. 2



Weese, modified Figs. 1-2

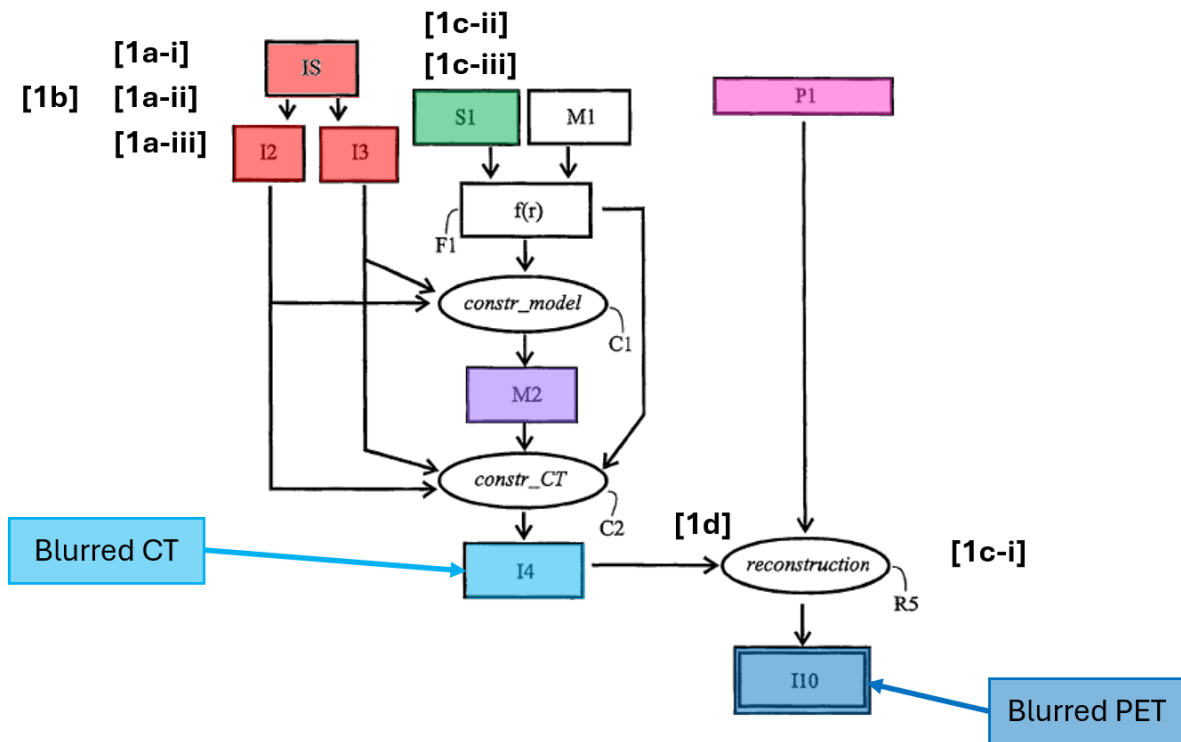


FIG.3

Weese, Fig. 3

a. First, Weese discloses “second movement states of the mobile object”

F1 and M2 describe [1d]’s “second movement states.” Peterson, [222]-[225]; §§VII.A, VIII.A. F1 may be “frequency function  $f(r)$ ” for “motion states  $r$ ” (e.g., position) describing “overall motion.” Weese, ¶¶[0043]-[0044], [0063]-[0067]; Figs. 4-5; Peterson, [222]. Also, M2 mathematically describes object “behavior” during motion. Weese, ¶¶[0012], [0023]-[0069], Figs. 4-5; Peterson, [223]-[225]. Vector fields are **motion models** indicating direction and speed of an “object component.” Weese, ¶¶[0066]-[0067]. For motion state  $r$ , Weese gives position as

$\vec{x}(r) = \vec{x}_3 + r\vec{m}(\vec{x}_3)$ , where  $\vec{x}_2$  and  $\vec{x}_3$  represent inhalation and exhalation, and  $\vec{m}(\vec{x}_3)$  describes object motion. *Id.*

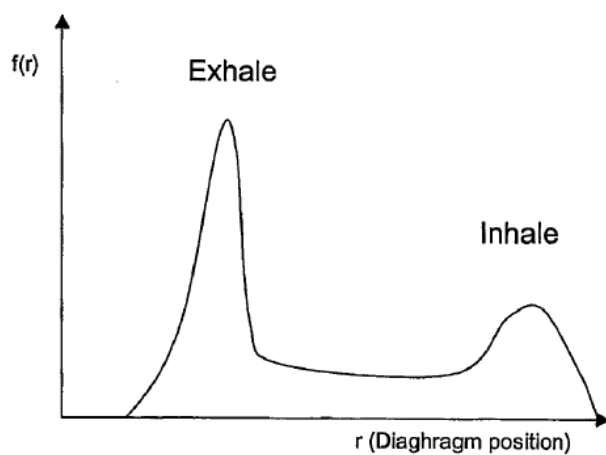


FIG.4

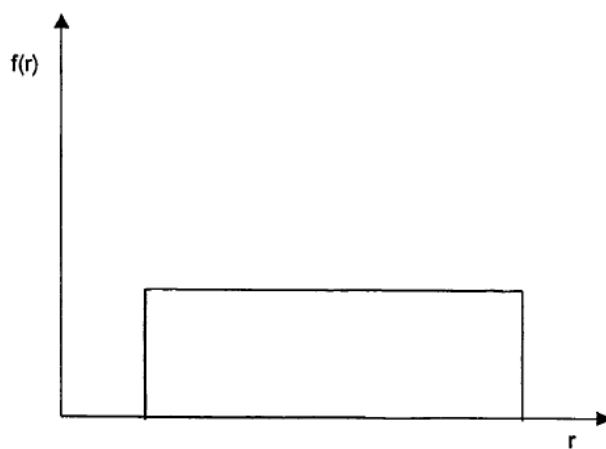


FIG.5

**Weese, Figs. 4-5**

- b. Second, Weese discloses “associating the plurality of second images with second movement states of the mobile object”

Weese associates **I0** (or **I10**) with F1 and **M2** *thirteen* ways. Peterson, [226]-[243].

i. Figure 1

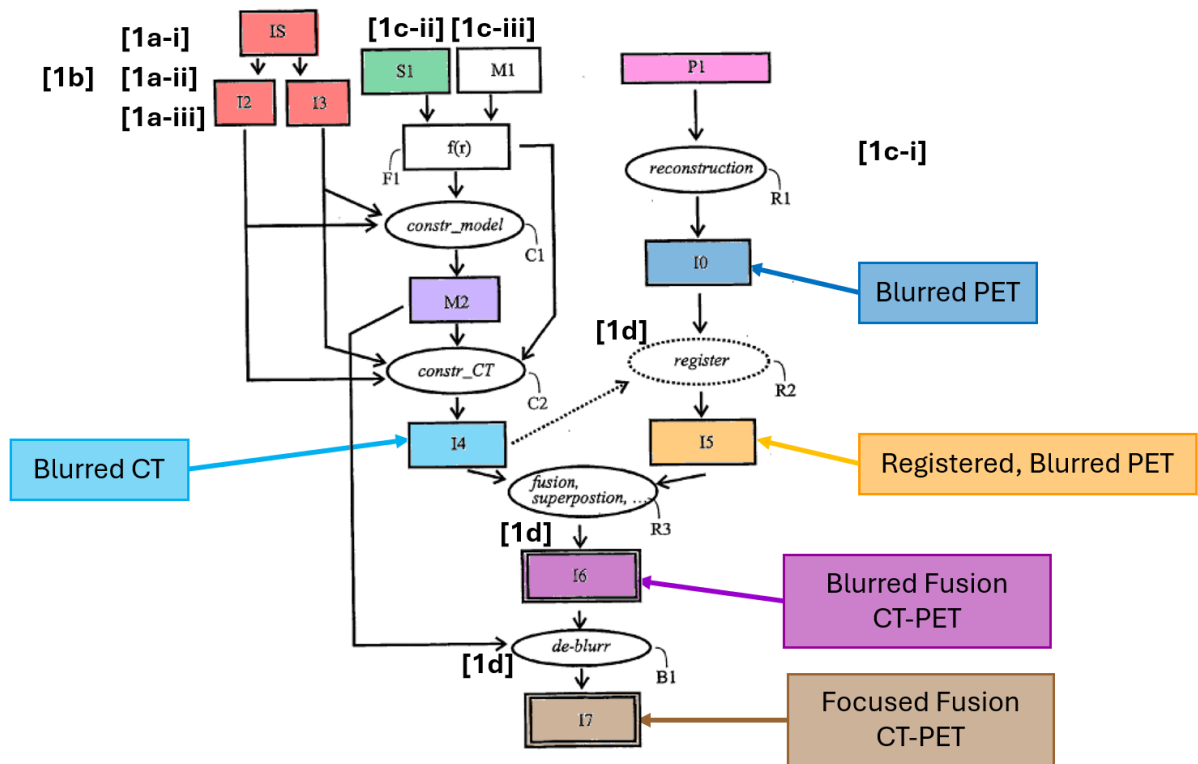


FIG.1

Weese, Fig. 1

Figure 1 discloses and renders obvious the “associating” three ways. Peterson, [228]-[233].

First, Weese employs **M2** to create **I4** for registering **I0** to form **I5** in separated PET-CT systems. Weese, ¶¶[0069], [0072]-[0075]. **I4** superimposes motion states

because it integrates **M2** over all states. Weese, ¶[0069]. Forming **I5** associates **M2**'s motion states with **I0** because:

- **I5** associates **I0** and **I4**; and
- **I4** is based on **M2**'s motion states.

Weese, ¶¶[0069], [0072]-[0075]; Peterson, [229].

Second, Figure 1 discloses this limitation by generating **I6**. Forming **I6** associates **M2**'s motion states with **I0** because:

- **I6** associates **I5** and **I4**;
- **I5** is based on **I0** and **I4**; and
- **I4** is based on **M2**'s motion states.

Weese, ¶¶[0069], [0075]-[0076], Fig. 1; Peterson, [230].

Third, Figure 1 discloses this limitation by using **M2** to deblur **I6** and create **focused, fusion CT-PET image I7**. For separated PET-CT systems, forming **I7** associates **M2**'s motion states with **I0** because:

- **I7** associates **M2**'s motion states with **I6**;
- **I6** is based on **I5**; and
- **I5** is based on **I0**.

Weese, ¶¶[0077], [0080], Fig. 1; Peterson, [231]. Combined PET-CT systems need no registration, so **I6** is based on **I0**. Weese, ¶¶[0072]-[0076]. Then, forming **I7** associates **M2**'s motion states with **I0** because:

- **I7** is based on **M2**'s motion states and **I6**; and
- **I6** is based on **I0**.

Weese, ¶¶[0072]-[0076], Fig. 1; Peterson, [232].

ii. **Figure 2**

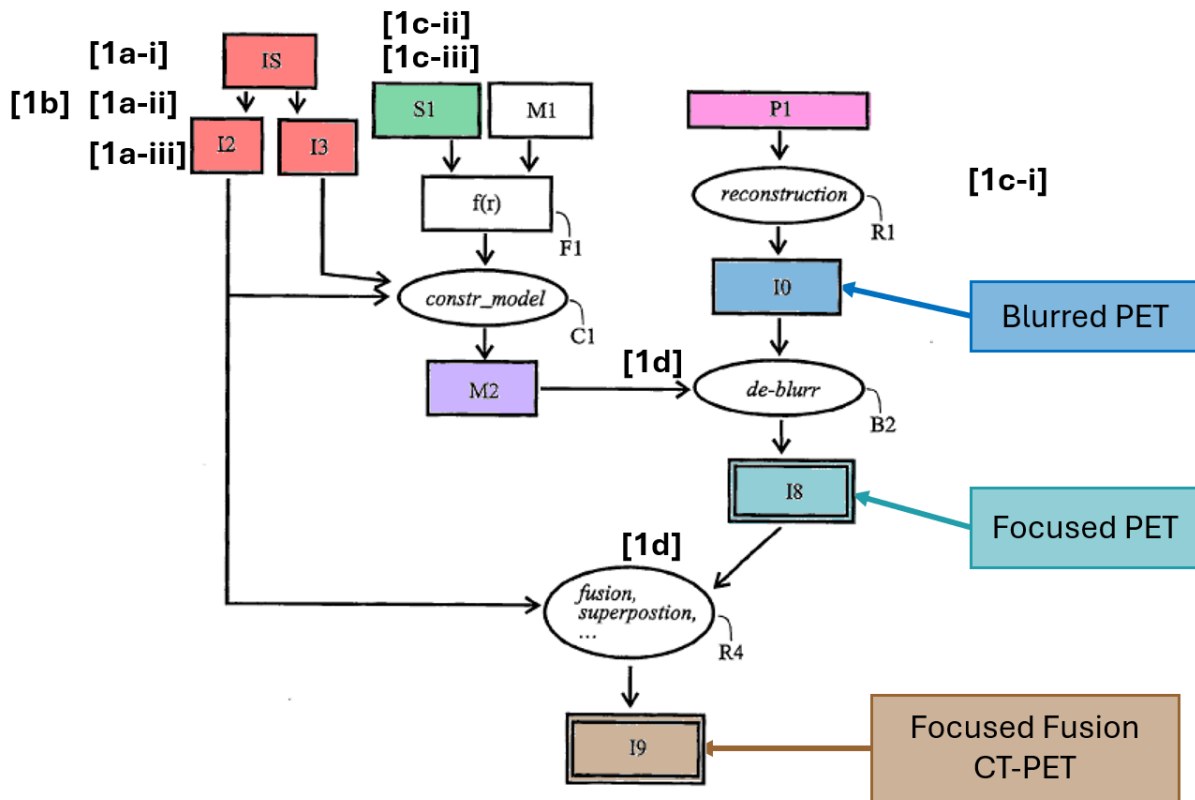


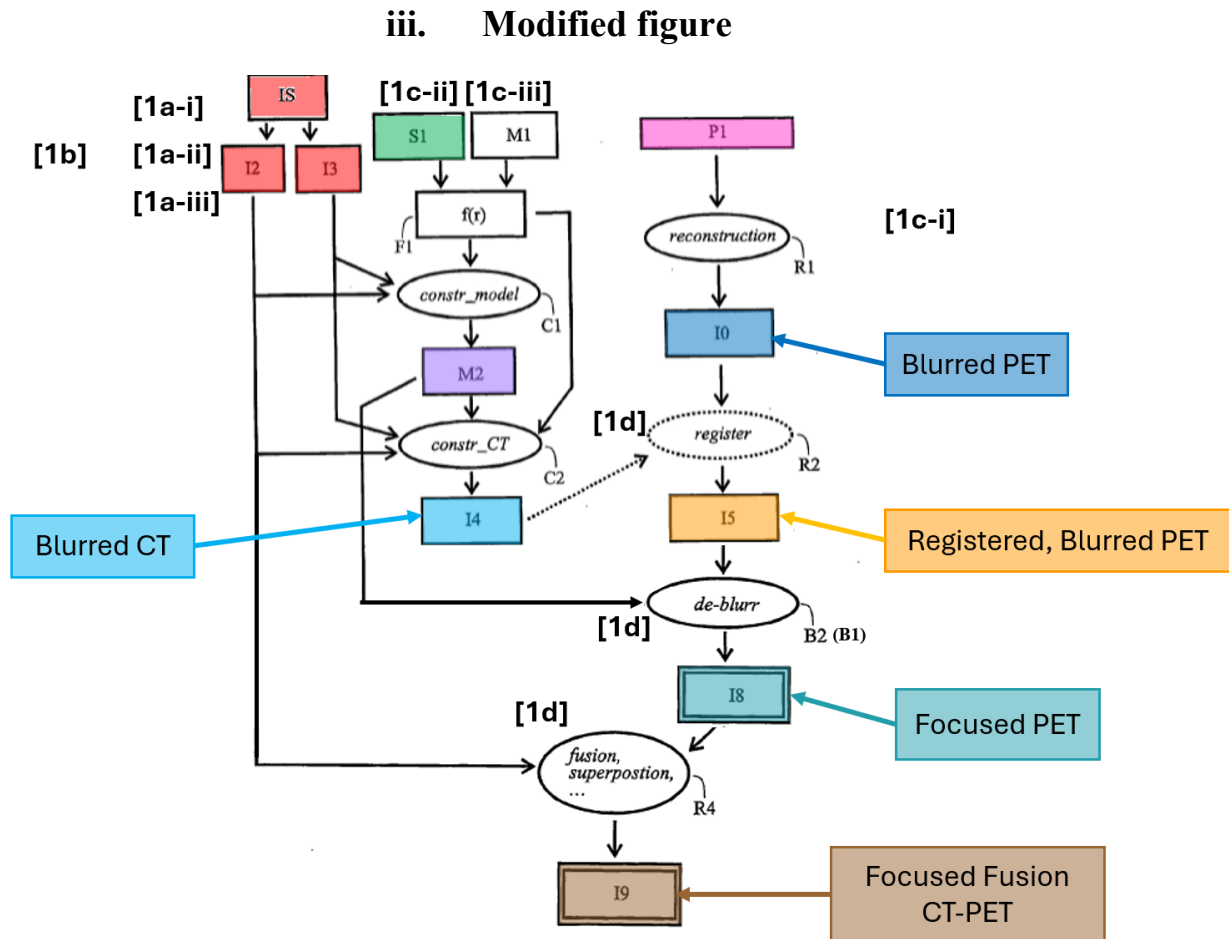
FIG.2

Weese, Fig. 2

Figure 2 discloses and renders obvious the “associating” two ways. Peterson, [234]-[236].

First, **M2** de-blurs **I0** to create **I8**, thereby associating **M2**’s motion states with **I0** for a combination CT-PET apparatus. Weese, ¶¶[0063]-[0069], [0078]-[0080], Fig. 2; Peterson, [235].

Second, by extension, forming **I9** also associates **M2**’s motion states with **I0** because **I9** is based on **I8**. Weese, ¶¶[0078]-[0080], Fig. 2; Peterson, [236].



Weese, modified Figs. 1-2

The modified figure discloses and renders obvious the “associating” three ways. Peterson, [237]-[240].

First, **M2** creates **I4** for registering **I0** to create **I5**. Weese, ¶[0080], Figs. 1-2; Peterson, [238]; §§VII.A, VIII.A. This associates **M2**’s motion states with **I0** for the same reasons as for Figure 1. §VIII.B.9.b.i; Peterson, [238].

Second, **M2** de-blurs **I5** to create **focused PET image I8**. §§VII.A, VIII.A. This associates **M2**’s motion states with **I5**, which is based on **I0**, and therefore associates **M2**’s motion states with **I0**. Peterson, [239].

Third, because **I9** is based on **I8** and **I2**, forming **I9** associates **M2**’s motion states with **I0** for the same reasons as for forming **I8**. Peterson, [240]; §§VII.A, VIII.A.

iv. Figure 3

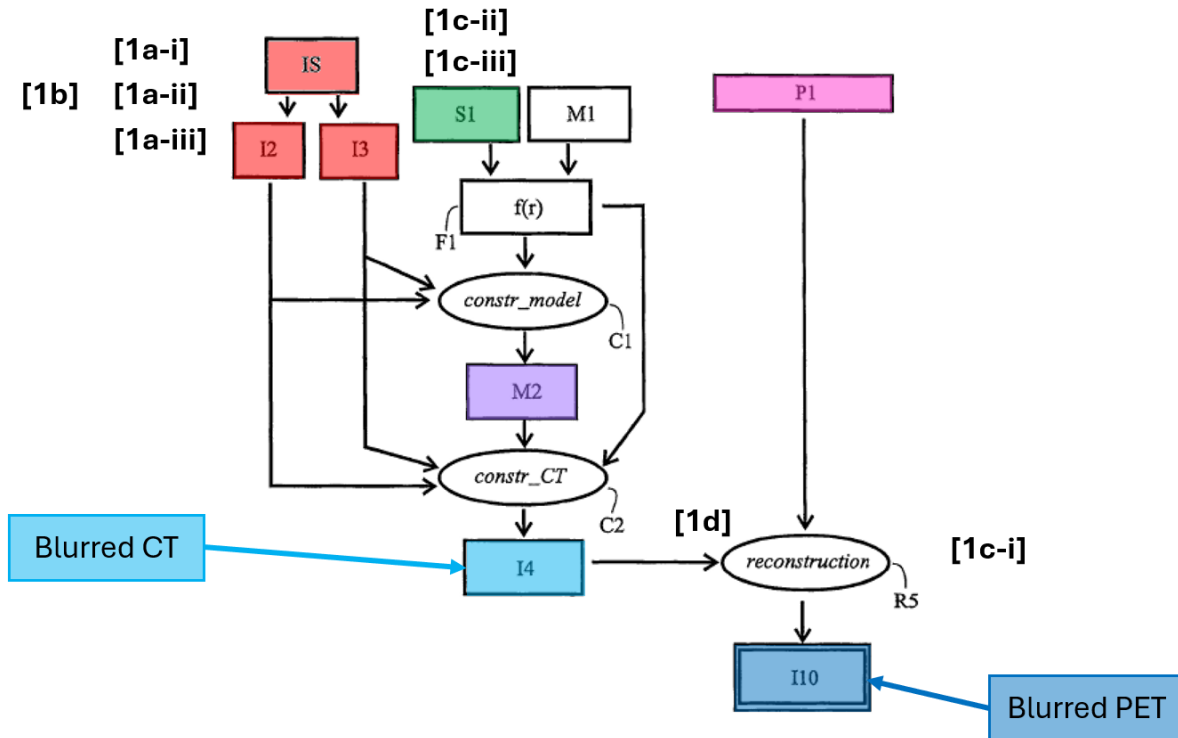


FIG.3

Weese, Fig. 3

Figure 3 discloses and renders obvious [1d] five ways—one way by itself, and four ways by combination with Figures 1-2. Peterson, [241]-[243].

First, **M2** forms **I4**, and **I4** reconstructs projections **P1** to create PET image **I10**, thereby associating **M2**'s motion states with **I10**. Weese, ¶¶[0078]-[0083], Fig. 3; Peterson, [242].

Next, because Figure 3's method "can be combined at will" with Figures 1-2, **I10** plays the role of **I0** in Figures 1 and 2 for combination CT-PET systems. Weese, ¶[0084]. Two ways that Figure 1 and two ways that Figure 2 disclose and render

obvious this limitation also apply to Figure 3. Peterson, [243]; §§VIII.B.9.b.i (forming **I6** and **I7** without registration), VIII.B.9.b.ii (forming **I8** and **I9**).

**c. Third, Weese discloses “associating ... *using the first measurements*”**

As explained, Weese discloses and renders obvious “associating ... second images with second movement states” multiple ways based on **M2**. §§VIII.B.9.a-b. Weese does so “*using the first measurements*” because **M2** is derived from **I2**, **I3**, and F1; and **I2** and **I3** are, in turn, based on measurements from **sensor 15**. Weese, ¶¶[0057]-[0067], Figs. 1-2, 6; Peterson, [244]-[245]; §§VII.A, VIII.A, VIII.B.3.

**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,**

Weese discloses and renders obvious [1e] *thirteen* ways by forming “image[s] of the mobile object”:

- **I5**, **I6**, and **I7** (Figure 1);
- **I8** and **I9** (Figure 2);
- **I5**, **I8**, and **I9** (modified figure);
- **I10** (Figure 3);
- **I6**, and **I7** (Figures 1 and 3 combination for combined CT-PET (§VIII.B.10.i;

Weese, ¶[0084])); and

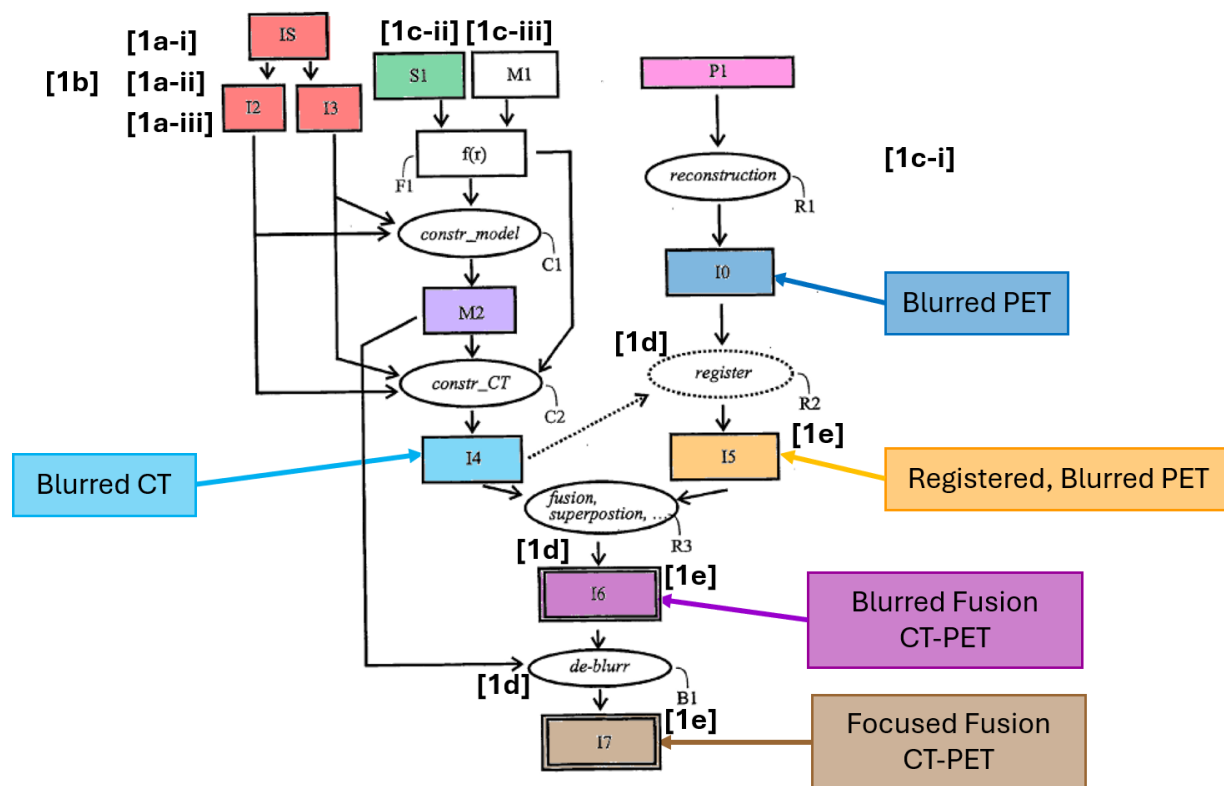
- **I8** and **I9** (Figures 2 and 3 combination (§VIII.B.10.ii; Weese, ¶[0084])).

Peterson, [246]-[255]; Weese, ¶¶[0047]-[0084], Figs. 1-3. **I5** is only formed for separate PET-CT systems. Weese, ¶¶[0072]-[0075], [0080]. And Figure 3's methods only apply to combination systems. Weese, ¶¶[0081]-[0084].

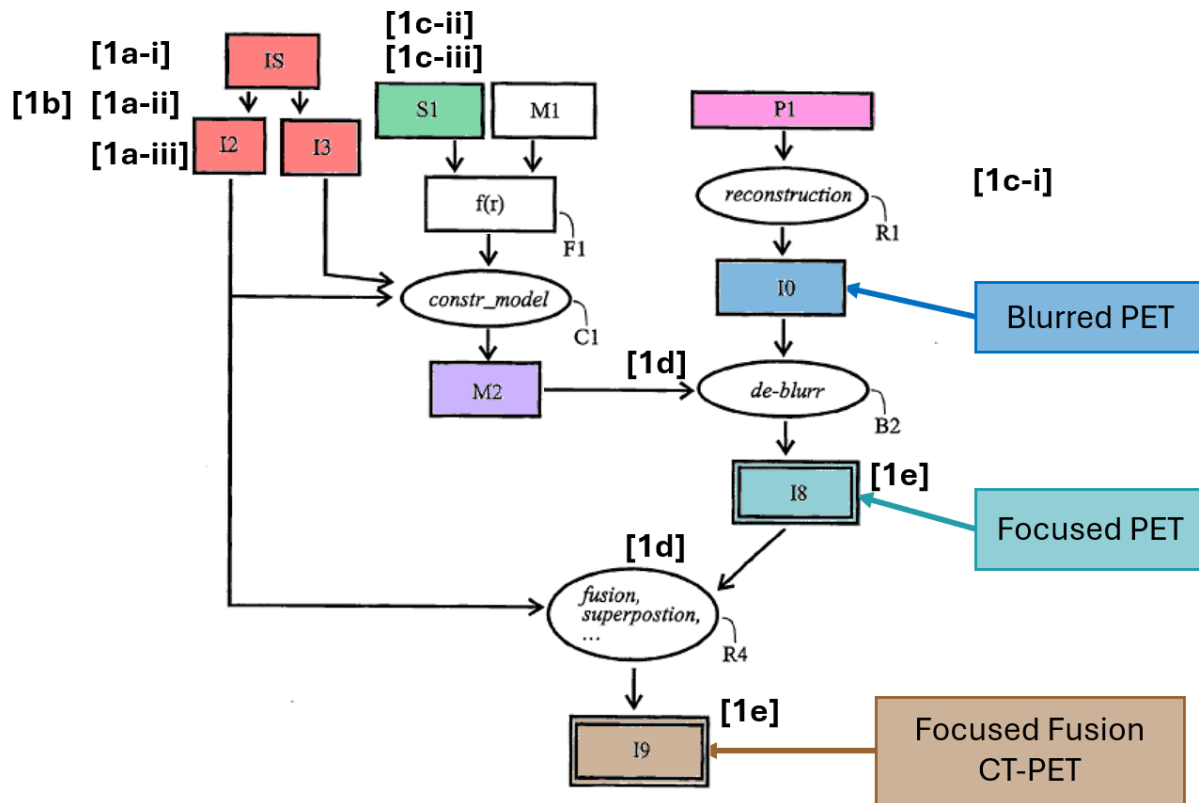
Each image listed above is formed based on:

- “first images” **I8**, **I2**, and **I3**, corresponding to “first movement states” based on “first measurements” from **sensor 15** (§§VIII.B.2-VIII.B.3);
- “second images” **I0** or **I10** (§VIII.B.6);
- F1, describing “second movement states” based on “second measurements” from **S1** (§VIII.B.7); and
- **M2**, based on “first movement states” of **I2** and **I3**, “first measurements” from **sensor 15**, and “second movement states” and “second measurements” from **S1** (§VIII.B.7).

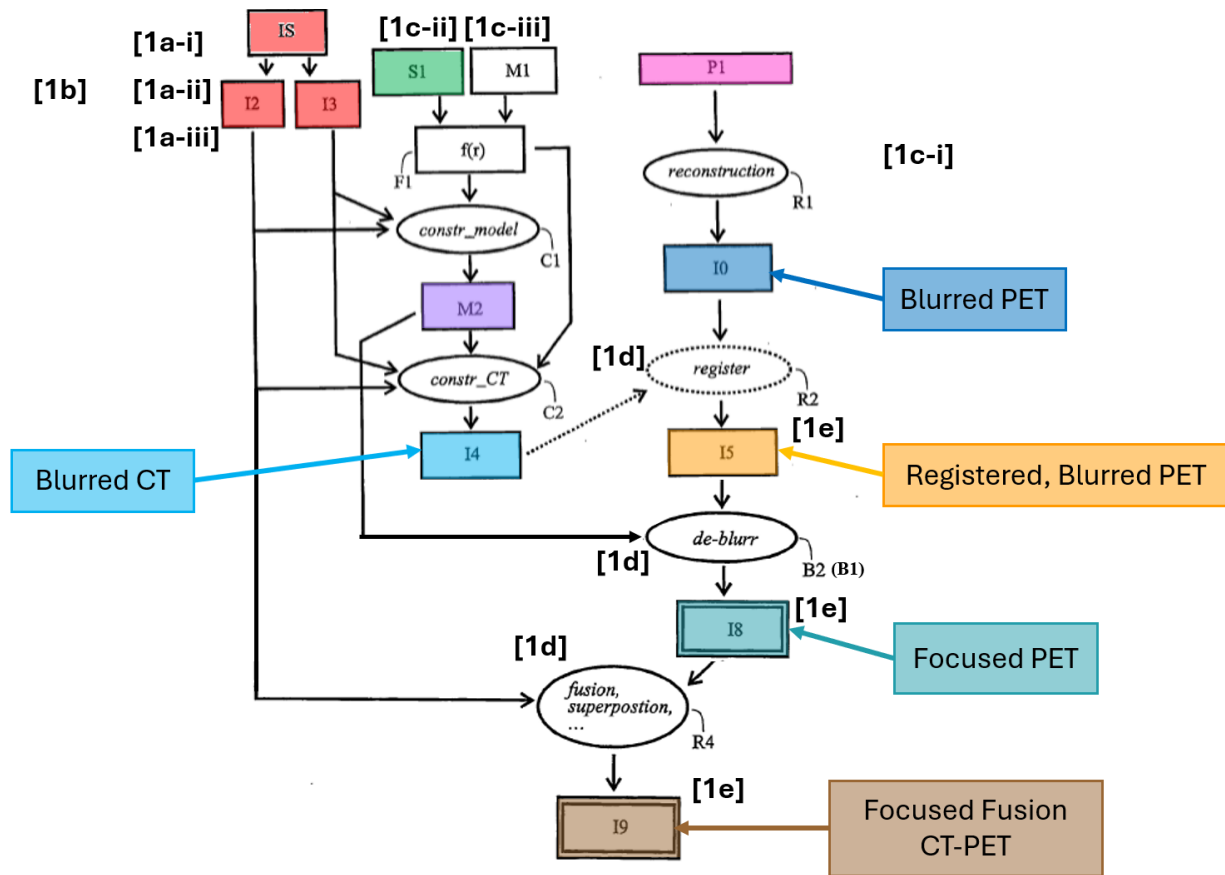
Peterson, [246]-[255]; Weese, ¶¶[0047]-[0084], Figs. 1-3. Some listed images are also based on **I4**, derived using **M2**, which further discloses [1e]'s forming: **I5**, **I6**, and **I7** (Figure 1); **I5**, **I8** and **I9** (modified figure); and **I10** (Figure 3). Weese, ¶¶[0069]-[0084], Figs. 1-3; §§VIII.B.6-VIII.B.7; Peterson, [246]-[255].



Weese, Fig. 1



Weese, Fig. 2



Weese, Figs. 1-2 (modified)

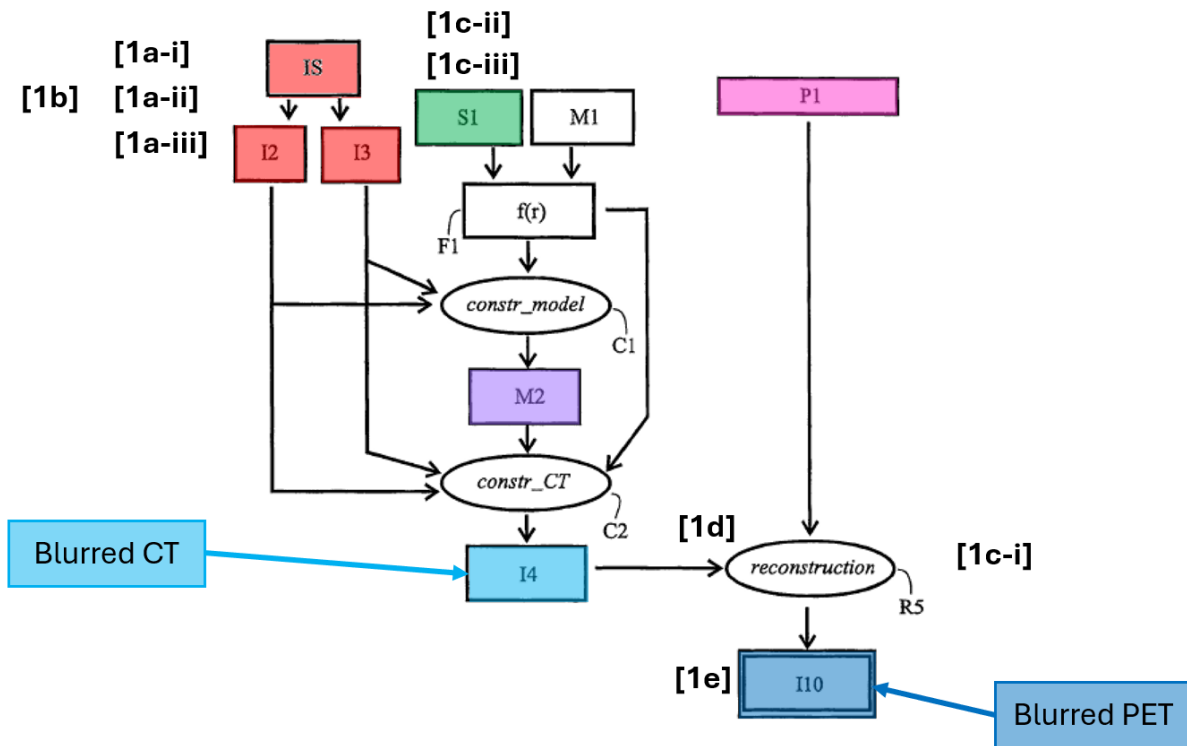


FIG.3

Weese, Fig. 3

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

Weese discloses [1f]. Peterson, [256]-[257]. CT is a first imaging technique, while PET is a second, different technique. *Id.*; §§VIII.B.2-VIII.B.4, VIII.B.6-VIII.B.8.

### C. Claim 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.**

Weese discloses claim 2.

**I2** and **I3** are “first images” (§VIII.B.2), and **I0** discloses or renders obvious “second images” (§VIII.B.6). Peterson, [258]-[259]. Figures 2-3 and the modified figure each disclose the additional claim 2 features. Peterson, [259]-[262].

**M2** is based on a comparison of first and second movement states. Weese, ¶¶[0063]-[0069], Figs. 1-2; Peterson, [260]-[262]. Weese time synchronizes CT and PET and creates a common time scale by comparing **S1** movement states with **I2** and **I3** when using **M2** to:

- focus **I0** to generate **I8** (Figure 2);
- focus **I5** to generate **I8** (modified figure); or
- form **I4**, then using **I4** to reconstruct projections **P1** and create **I10** (Figure 3).

Weese, ¶¶[0063]-[0084], Figs. 1-2; §VIII.B.9; Peterson [260]-[262].

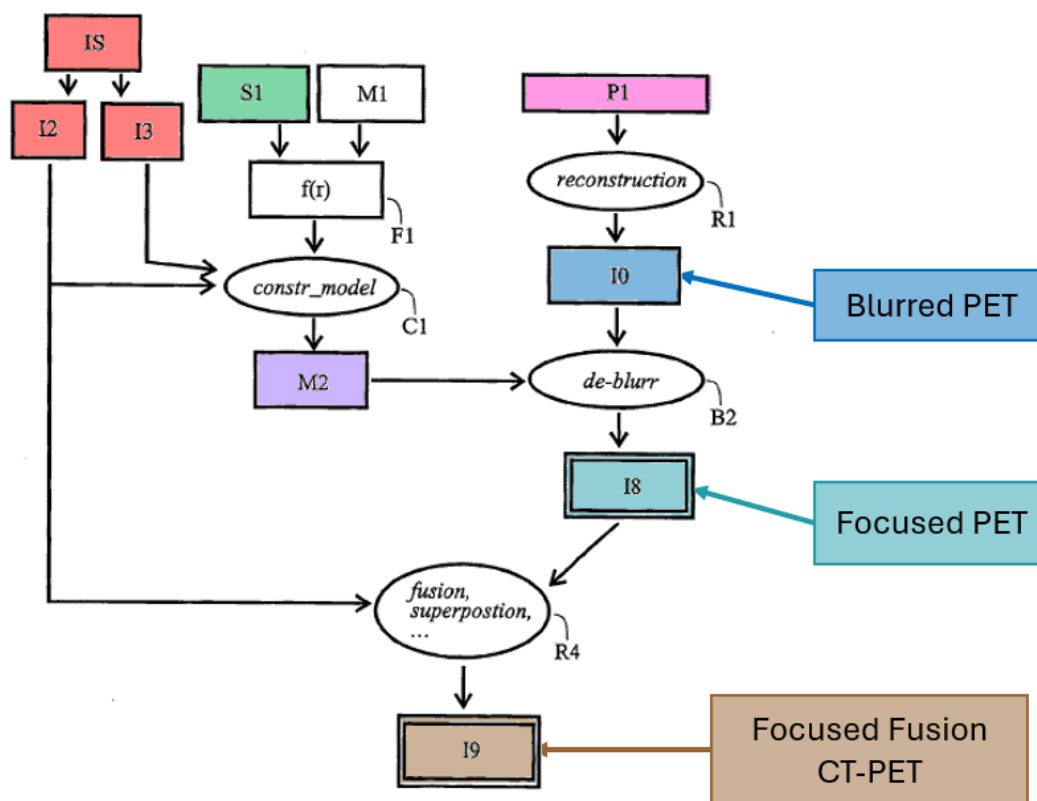
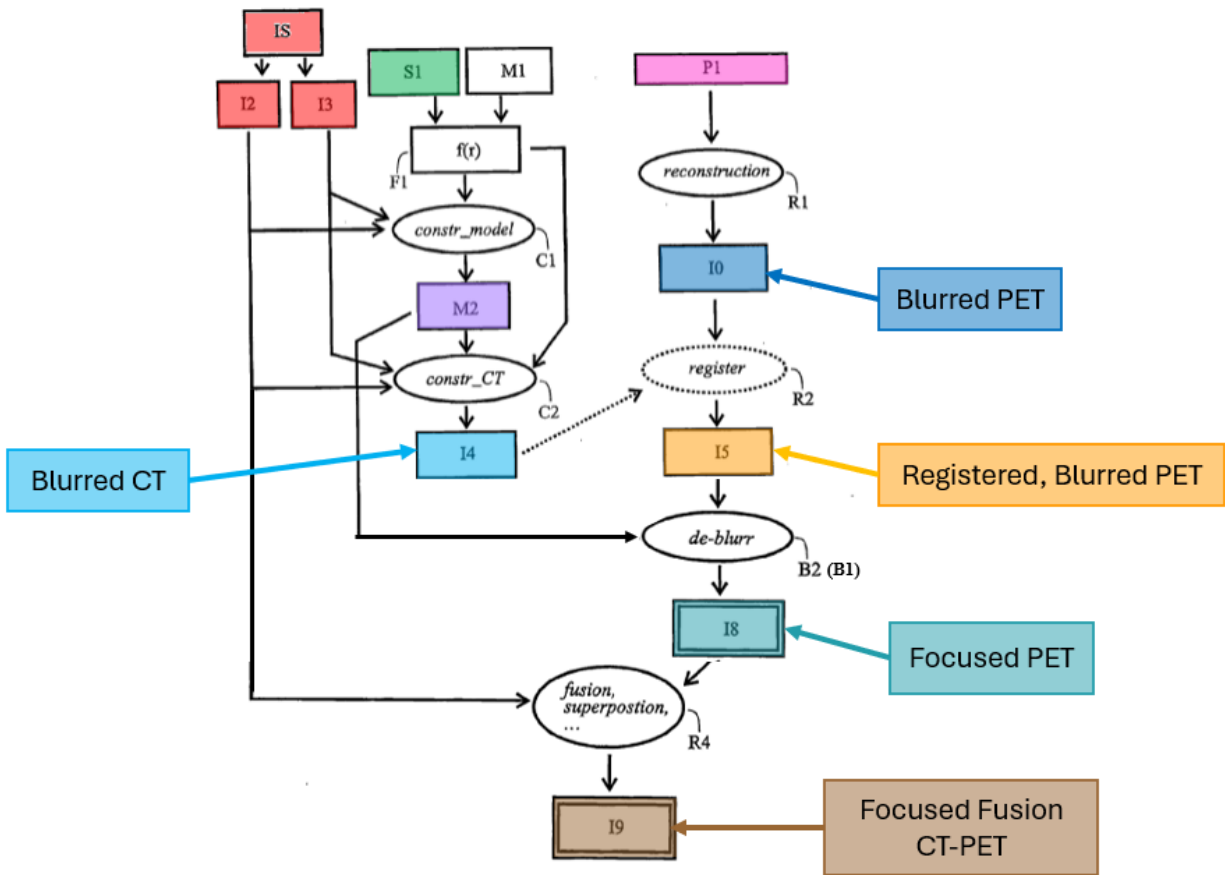


FIG.2

Weese, Fig. 2



Weese, modified Figs. 1-2

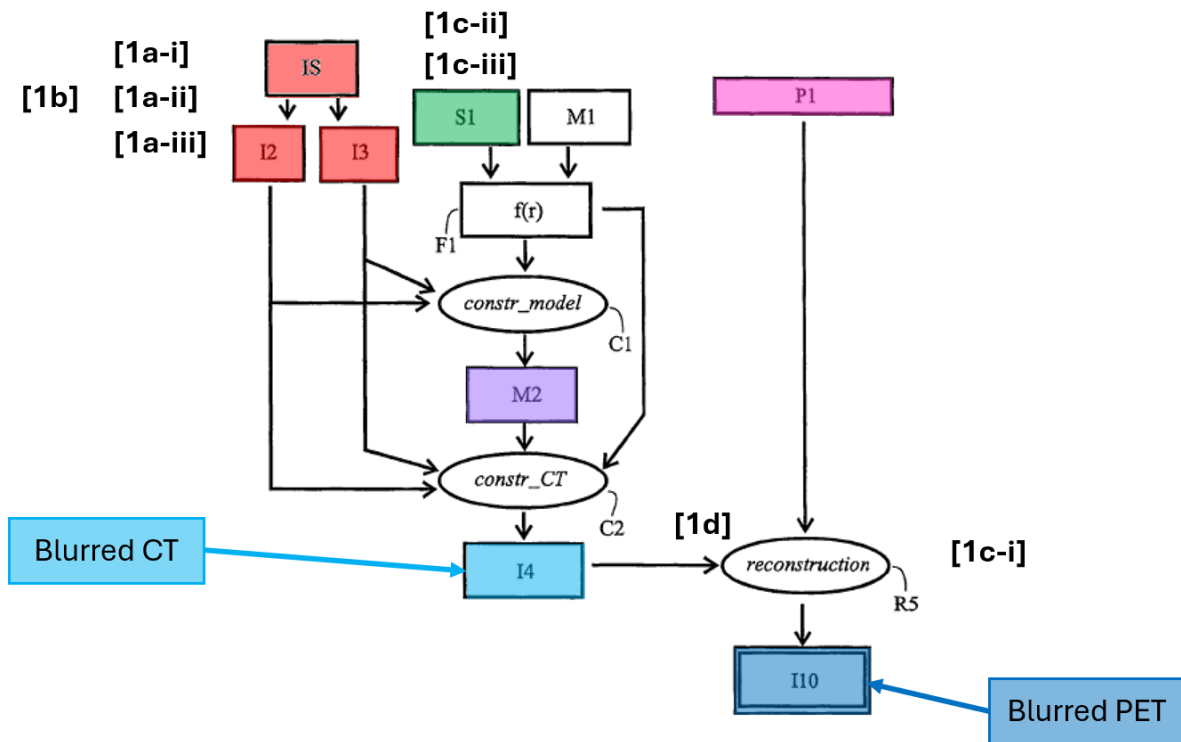


FIG.3

Weese, Fig. 3

#### D. Claim 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.

Weese discloses and renders obvious claim 3.

CT images **IS**, **I2**, and **I3** are “first images” reconstructed from X-ray projections and PET images **I0** and **I10** are “second images” reconstructed from projections **P1**. Weese, ¶¶[0047]-[0084], Figs. 1-3; §§VIII.B.2, VIII.B.6; Peterson, [263]-[265].

**E. Claim 4**

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

Weese discloses and renders obvious claim 4.

Registration is spatial synchronization. Ex-1001, 3:54-61; Peterson, [267]; Weese, ¶¶[0073]-[0074]; Ex-1009; Ex-1011, ¶¶[0011], [0013]-[0014], [0033]. The patent admits this “is not innovative.” Ex-1001, 3:54-61.

Weese’s **I5**, **I2**, and **I3** disclose “first reconstructed images,” and **I0** discloses and renders obvious “second reconstructed images.” §VIII.D. Weese spatially synchronizes these images two ways. Peterson, [268]-[270].

First, for separate PET-CT systems, Weese registers **I0** to **I5**, **I2**, and **I3** coordinates to create **I5**. Weese, ¶¶[0072]-[0080], Fig. 1; §§VII.A; Ex-1009. Like the ’353 patent’s registration, Weese’s registration accounts translation, rotation, affine, and other transformations. Ex-1001, 3:62-4:44; Weese, ¶¶[0073]-[0074]; Ex-1009, 1610-11; Peterson, [269].

Second, combination CT-PET systems “automatically” spatially synchronize CT and PET images. Weese, ¶¶[0072]-[0084], Figs. 1-3. This accords with the ’353 patent’s “simplest case” of spatial synchronization with no movement between attenuation and emission. Ex-1001, 4:42-44; Peterson, [270].

**F. Claim 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.**

Weese discloses and renders obvious claim 5.

CT is a “radiation attenuation technique,” while PET is a “radiation emission technique.” Weese, ¶¶[0047]-[0084]; §§VIII.B.2, VIII.B.6; Peterson, [271]-[273].

#### **G. Claim 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.**

Weese discloses and renders obvious claim 6.

Registration is spatial synchronization. §VIII.D. Registration of “second images” **I0** to **I4** discloses claim 6 because **I4** is based on: **M2**, “first images” **IS**, **I2**, and **I3**; “first measurements” from **sensor 15**; and “second measurements” from **S1**. Weese, ¶¶[0063]-[0080], Figs. 1-2; §§VII.A, VIII.A, VIII.B.3, VIII.B.9; Peterson, [274]-[276].

#### **H. Claim 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.**

Weese discloses and renders obvious claim 7.

Motion vector fields of **M2** are “displacement fields” per claim 7 because they mathematically describe how points in an image move. Weese, ¶¶[0063]-[0067];

Peterson, [277]-[283]. Vector fields indicate direction and speed a pixel or “object component” moves. Weese, ¶[0066]. Weese provides a position formula for each motion state  $r$  as  $\vec{x}(r) = \overrightarrow{x_3} + r\vec{m}(\overrightarrow{x_3})$ , where  $\overrightarrow{x_2}$  represents inhalation,  $\overrightarrow{x_3}$  represents exhalation, and motion vector field  $\vec{m}(\overrightarrow{x_3})$  describes motion. Weese, ¶[0067].

Weese’s motion vector fields correspond to “first images” **I2** and **I3**. Weese, ¶¶[0063]-[0068]. For breathing,  $\vec{x}(r = 0) = \overrightarrow{x_3}$  represents “the exhaled state” corresponding to **I3**, and  $\vec{x}(r = 1) = \overrightarrow{x_2}$  represents “the inhaled state” corresponding to **I2**. Weese, ¶[0067]. Motion vectors  $\vec{m}(\overrightarrow{x_3})$  describe object motion and  $\vec{x}(r)$  gives object position; both are “displacement fields corresponding, respectively, to ... first images” **I2** and **I3**, per claim 7. Weese, ¶¶[0066]-[0067]; Peterson, [278]-[279].

Motion vector fields also correspond to “first measurements” because **I2** and **I3** correspond to “first measurements” when extracted from **IS** using **sensor 15** measurements. Weese, ¶¶[0031], [0057]-[0080]; Peterson, [280]; §§VII.A, VIII.A, VIII.B.3.

Further, Weese’s motion vector fields correspond to “second measurements” because the “actual motion” from **S1** during PET acquisition determines F1 and generates motion vectors. Weese, ¶¶[0065]-[0067]; Peterson, [281]; §VIII.B.7.

The motion vector fields also correspond to “second images” **I0** in two ways. Peterson, [282]. First, **I0** superimposes motion states by integrating the frequency function, an initial state, and motion vectors over all motion states:

$$\int_0^1 f(r)I0_a(\vec{x}_a + \overrightarrow{rm}(\vec{x}_a)dr$$

Weese, ¶¶[0070]-[0071]. Second, Weese uses **M2** to focus **I0** (Figure 2, modified figure). Weese, ¶¶[0078]-[0080], Fig. 2; Peterson, [282]; §§VII.A, VIII.A.

### **I. Claim 8**

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

Weese discloses and renders obvious claim 8.

Weese “form[s] an image of a mobile object” by forming:

- **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 (Weese, ¶[0084]))
- and **I8** and **I9** (combination of Figures 2 and 3 (Weese, ¶[0084])).

§VIII.B.10; Peterson, [284]-[285].

Weese forms each above-listed image using **M2**, which teaches claim 7’s “displacement fields.” Peterson, [285]; §§VIII.B.10, VIII.B.7. “[C]ombining

displacement fields” per claim 8 accounts for displacements between phases. Ex-1001, 7:24-29; Peterson, [285]. Applying M2 to form the above-listed images thus combines displacement fields because it accounts for displacements between phases. Peterson, [285]; §§VIII.B.9, VIII.B.10, VIII.B.7. By the above [1e] analysis, Weese teaches claim 8 *thirteen* ways. Weese, ¶¶[0069]-[0084], Figs. 1-3; §VIII.B.10.

For example, I4 is formed by integrating M2’s motion vectors over all motion states, which accounts for displacements between phases. Weese, ¶[0069]; Peterson, [286]. Then, forming images based on I4 (e.g., I5, I6, I8, I9, I10) comprises combining displacement fields, per claim 8. Peterson, [287]-[291]; §VIII.B.10.

#### J. Claim 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.**

Weese discloses and renders obvious claim 9.

M2’s motion vector fields are displacement fields. Weese, ¶¶[0063]-[0068]; Peterson, [293]; §VIII.H.

These fields are based on movement estimates between “first images” I2 and I3, which are extracted from IS using “first measurements” from motion sensor 15. §VIII.H; Weese, ¶¶[0031], [0057]-[0080]; §§VII.A, VIII.A, VIII.B.3, VIII.H. The movement estimates also derived from “second measurements” from sensor S1

collected while capturing projections **P1** of “second images” **I0**. Weese, ¶¶[0065]-[0067]; §§VIII.B.7, VIII.B.10. Weese accordingly teaches “estimating movement” based on “first images,” “second images,” “first measurements,” and “second measurements” to form displacement fields, per claim 9. Peterson, [292]-[295].

**K. Claim 10**

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

Weese discloses and renders obvious claim 10.

Weese obtains “actual motion” from **S1** to generate F1 when forming motion vectors. Weese, ¶¶[0065]-[0067]; Peterson, [296]-[297]. Motion vectors are calculated relative to F1’s parameter  $r$ , which varies between  $r=0$  and  $r=1$ , corresponding to “inhaled” and “exhaled state[s],” which are “reference time[s],” per claim 10. Weese, ¶¶[0065]-[0067], Figs. 4-5; Peterson, [297].

**L. Claim 11**

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

Weese discloses and renders obvious claim 11.

**Sensor 15** differs from **S1** in some embodiments (e.g., separate PET-CT systems). §§VII.A, VIII.A-VIII.B; Peterson, [298]-[299].

**M. Claim 12**

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

Weese discloses and renders obvious [12p], as discussed for [1p]. §VIII.B.1; Peterson, [300].

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

Weese discloses and renders obvious [12a-i].

[12a-i] is a means-plus-function term, and Weese discloses its function. §§VI.1, VIII.B.2; Peterson, [301]-[302].

The corresponding structure includes an attenuation or emission radiation source and detector, gantry, processor, and memory. §VI.1. Weese discloses these conventional features for CT systems alone or combined with PET. Weese, ¶¶[0053]-[0072], Fig. 6; §§V, VIII.B.2; Peterson, [303]-[304].

- 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,**

Weese discloses and renders obvious [12a-ii].

[12a-ii] is a means-plus-function term, and Weese discloses its function. §§VI.2, VIII.B.3; Peterson, [305]-[306].

The corresponding structure includes a breathing, pressure, or electrocardiogram sensor. §VI.2. Sensor 15 is a breathing sensor for CT systems alone or combined with PET. §VIII.B.3; Peterson, [307].

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

Weese discloses and renders obvious [12a-iii], as discussed for [1a-iii]. §VIII.B.4; Peterson, [308].

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;**

Weese discloses and renders obvious [12b].

[12b] contains a means-plus-function term, and Weese discloses its function. §§VI.3, VIII.B.5; Peterson, [309]-[310].

The corresponding structure presumably includes a computer programed to perform the associating. §VI.3. Weese discloses it because Weese implements conventional computerized methods. Weese, Abstract, ¶¶[0001], [0038]; Peterson, [311]-[312]; Ex-1008, 61-93; §§V, VIII.B.5. Weese discloses an “image processing system” capable of receiving and processing image data. Weese, ¶[0036]. Weese also discloses a “data processing unit” that runs a computer program on media and

combines CT and PET, reduces motion artifacts, and visualizes images. Weese, ¶¶[0038], [0060], claims 10, 12.

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

Weese discloses and renders obvious [12c-i].

[12c-i] is a means-plus-function term, and Weese discloses its function. §§VI.4, VIII.B.6; Peterson, [313]-[314].

The corresponding structure includes an attenuation or emission radiation source and detector, gantry, processor, and memory. §VI.4. Weese discloses these conventional features for PET systems alone or combined with CT. Weese, ¶¶[0047]-[0061], [0072], Fig. 6; §§V, VIII.B.6; Peterson, [315]-[316].

**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,**

Weese discloses and renders obvious [12c-ii].

[12c-ii] is a means-plus-function term, and Weese discloses its function. §§VI.5, VIII.B.7; Peterson, [317]-[318].

The corresponding structure includes a breathing, pressure, or electrocardiogram sensor. §VI.5. S1 is a breathing sensor for CT systems alone or combined with PET. Peterson, [319]; §VIII.B.7.

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

Weese discloses and renders obvious [12c-iii], as discussed for [1c-iii].  
§VIII.B.8; Peterson, [320].

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**

Weese discloses and renders obvious [12d] for reasons provided for [1d].  
[12d] contains a means-plus-function limitation, and Weese discloses its function. §§VI.6, VIII.B.7; Peterson, [321]-[323].

Further, [12d] requires determining “second movement states” by “*second* measurements,” while [1d] requires “associating ... second images with second movement states ... using the *first* measurements.” The same processes that disclose [1d] also disclose [12d] because M2 relies on “first measurements” from motion sensor 15 to extract CT images I2 and I3, and M2 relies on “second measurements” from sensor S1 to capture motion when collecting PET projections P1. §§VIII.B.7, VIII.B.9; Peterson, [321]-[323]. This holds whether sensor 15 is the same as S1 or different. Peterson, [321]-[323]; §§ VIII.B.7, VIII.B.9.

The corresponding structure presumably includes a computer programmed to perform the associating. §VI.6. Weese's methods too are computerized. §§VIII.M.5, VIII.B.9; Peterson, [324]-[325].

- 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,**

Weese discloses and renders obvious [12e].

[12e] is a means-plus-function term, and Weese discloses its function. §§VI.7, VIII.B.10; Peterson, [326]-[327].

The corresponding structure presumably includes a computer programmed to perform the forming. §VI.7. Weese's methods too are computerized. §§VIII.M.5, VIII.B.10; Peterson, [328]-[329].

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

Weese discloses and renders obvious [12f], as discussed for [1f]. Peterson, [330]; §VIII.B.11.

- N. Claim 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.**

Weese discloses and renders obvious claim 13.

Claim 13 is a means-plus-function term, and Weese discloses its function. §§VI.8, VIII.D; Peterson, [331]-[332].

The corresponding structure presumably includes a computer programmed to perform the forming. §VI.8. Weese's methods are also computerized. §§VIII.M.5, VIII.D; Peterson, [333]-[334].

**O. Claim 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.**

Weese discloses and renders obvious claim 14, as discussed for claim 5. Peterson, [335]; §VIII.F.

**P. Claim 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.**

Weese discloses and renders obvious claim 15.

Claim 15 is a means-plus-function, and Weese discloses its function. §§VI.9, VIII.H; Peterson, [336]-[337].

The corresponding structure presumably includes a computer programmed for forming displacement fields. §VI.9. Weese's methods are likewise computerized. §§VIII.H, VIII.M.5; Peterson, [338]-[339].

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

Weese discloses and renders obvious claim 16.

Claim 16 is a means-plus-function term, and Weese discloses its function.

§§VI.10, VIII.I; Peterson, [340]-[341].

The corresponding structure presumably includes a computer programmed for combining displacement fields. §VI.10. Weese's methods too are computerized.

§§VIII.I, VIII.P; Peterson, [343].

**R. Claim 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.**

Weese discloses and renders obvious claim 17.

Claim 17 contains a means-plus-function term, and Weese discloses its function. §§VI.11, VIII.J; Peterson, [344]-[345].

The corresponding structure presumably includes a computer programmed for estimating movement based on images and measurements. §VI.11. Weese's methods are also computerized. §§VIII.J, VIII.P; Peterson, [346]-[347].

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

Weese discloses and renders obvious claim 18, as discussed for claim 10. §VIII.K; Peterson, [348].

**IX. GROUND 2 (WEESE AND MUEHLLEHNER)**

Claims 1-18 are unpatentable over Weese and Muehllehner. Peterson, [349]-[365].

**A. Overview**

Weese's I0 and I10 may be "volume images" created using "known" techniques. Weese, ¶¶[0002], [0026], [0048], [0058], [0061]; §VIII.B.6.a. A POSITA would have been familiar with rendering volumes from 2D slices, rendering [1c-i] obvious over Weese and a POSITA's knowledge. Peterson, [350]-[352]; §VIII.B.6.a.

If Patent Owner disagrees, [1c-i] would also have been obvious over Weese and Muehllehner. Peterson, [353]-[358]. Weese omits volume imaging details that Muehllehner's slice-by-slice methods provide. *Id.*; Weese, ¶¶[0002], [0026], [0048], [0058], [0061]; Muehllehner, Abstract, 1:65-2:14, 12:48-60, 13:18-38, Figs. 2, 2a, 11-13. The combination employs Muehllehner's volume techniques to make I0 and I10 and otherwise leaves Weese's methods unchanged. Peterson, [354]; §VIII.

The combination's implementation would have been predictable. Peterson, [355]-[356]. Weese calls for "known" volume imaging methods, and Muehllehner provided one such suitable option. Peterson, [351]-[358]; Weese, ¶¶[0026], [0048], [0058]. Muehllehner uses the same equipment as Weese to collect slices and reconstruct PET images, including detectors, a gantry, and a computer system. Muehllehner, 3:27-58, Fig. 1; Weese, ¶¶[0047]-[0051], [0058], Fig. 6; §§VIII.B.6.a.i, VIII.M.6. Muehllehner's methods would have reduced blurring, a goal both references share. Peterson, [356]; Weese, ¶¶[0002]-[0004], [0049]; Muehllehner, Abstract, 1:13-63, 6:49-9:3. Muehllehner processes projection data that Weese also collects. Muehllehner, Abstract, 1:13-63, 6:49-9:3; Weese, ¶¶[0047]-[0051], [0058], Figs. 1-3; Peterson, [356]. POSITAs would have successfully reduced Weese's blurring with Muehllehner's iterative reconstruction. Peterson, [356].

In addition, POSITAs would have used Muehllehner's methods to improve efficiency because they save time and cost with multi-slice rebinning and axial filtering. Muehllehner, 2:39-63, 10:54-67, 11:24-30; Peterson, [357].

Ground 2's analysis only differs from Ground 1 for [1c-i] and [12c-i]. Peterson, [358]. For all other limitations, the combination renders the claims obvious for reasons of Ground 1. *Id.*; §VIII.

**B. [1c-i]**

I0 and I10 are “second images” obtained with a “second imaging technique.” §VIII.B.6. POSITAs would have used Muehllehner’s 3D PET volume methods to generate volumetric I0 and I10. §IX.A; Peterson, [359]-[361]. This involves collecting slices and applying a “two-dimensional iterative reconstruction algorithm ... to reconstruct a three-dimensional image, slice-by-slice,” as was widely used. Muehllehner, 2:10-14, 4:10-25, 6:63-9:3, 11:48-63, 13:18-39, Figs. 2-2A; Peterson, [359]-[361].

FIG. 2

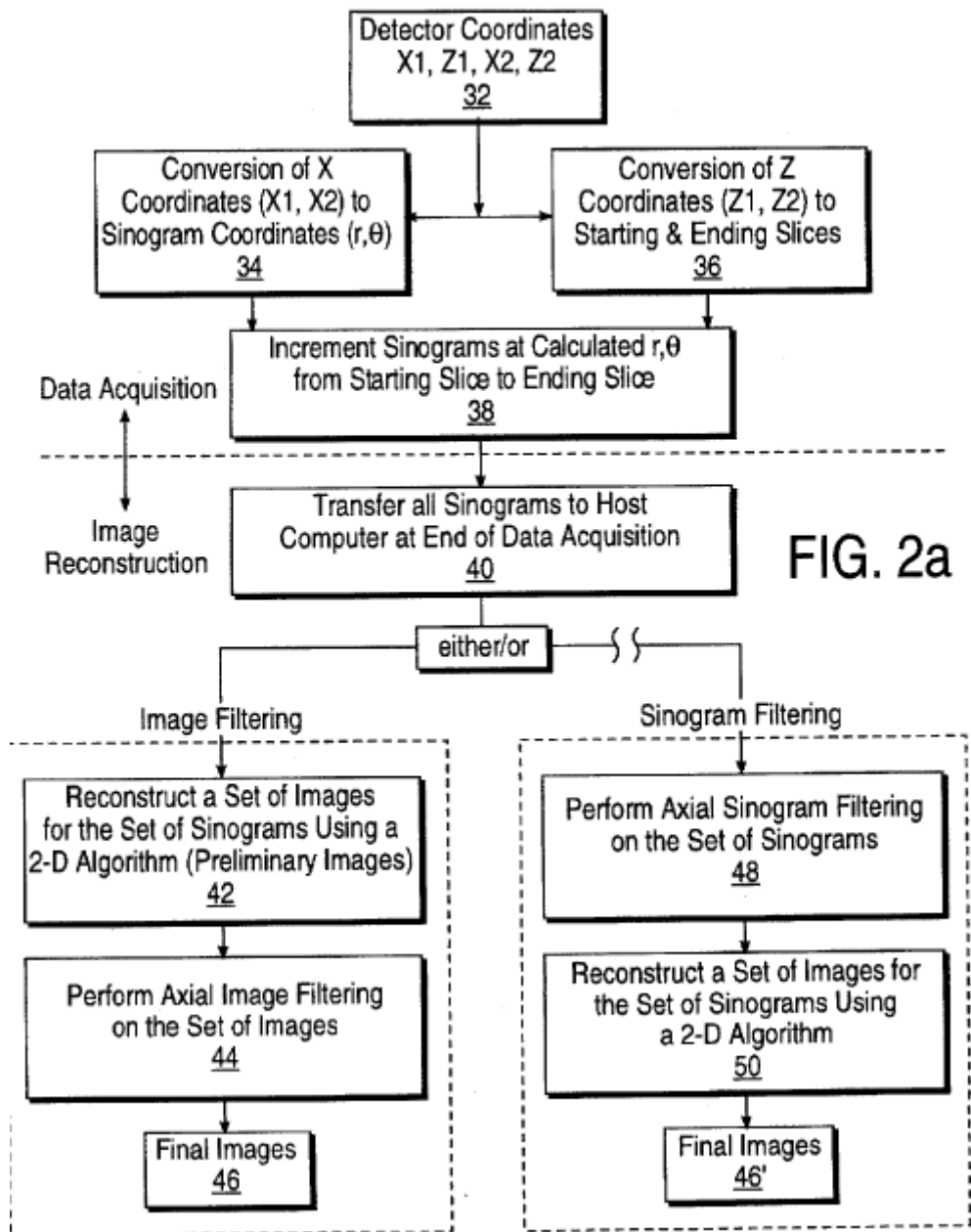


FIG. 2a

Muehllehner, Figs. 2-2a

C. [12c-i]

Weese and Muehllehner renders obvious [12c-i].

[12c-i] is a means-plus-function term, and Weese-Muehllehner renders obvious its function. Peterson, [262]-[263]; §§VI.4, IX.B.

The corresponding structure includes an attenuation or emission radiation source, detector, gantry, processor, and memory. §VI.4. Weese's and Muehllehner's conventional systems disclose it. Weese, ¶¶[0047]-[0061], [0072], Fig. 6; Muehllehner, 1:66-2:14, 3:27-58, Fig. 1; §§V, VIII.M.6; Peterson, [264]-[265].

## **X. GROUND 3 (WEESE AND WAINER)**

### **A. Weese and Wainer**

POSITAs would have used Wainer's gating to reduce artifacts in Weese's **10**, improving reliability and precision. Peterson, [366]-[376]. Both references match structural and functional images by removing artifacts at common motion states. *Id.*; Weese, Title, Abstract, ¶¶[0001]-[0038], [0047]-[0084], Figs. 1-6; Wainer, 1:10-15, 2:3-21, 3:33-60, 8:38-49. They teach compatible and interchangeable ways to match: Weese "focus[es]" on one motion state (Weese, ¶¶[0020]-[0022], [0033], [0071]-[0080], Figs. 1-2); Wainer gates images by phase (Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6). Peterson, [366].

Weese flexibly encourages using multiple methods to correct artifacts and combines images. *E.g.*, Weese, Abstract, ¶¶[0013]-[0019], [0029], [0047]-[0084],

Figs. 1-3; Peterson, [367]; §§VII.A, VII.A.2. POSITAs would have desired various views to enable comparison or combination. Weese, ¶[0075]. Weese seeks “to increase the information content of images containing motion artifacts.” Weese, ¶[0004]. POSITAs would have looked for ways to improve reliability and precision. Peterson, [367]. Wainer describes one such method. Peterson, [368].

Wainer employs conventional, textbook gating to reduce “smearing” and facilitate registration. Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6; Peterson, [368]; Ex-1008, 452, 696-698; §VII.C. POSITAs would have used Wainer’s gating to satisfy Weese’s goal to increase information content and reduce artifacts. Peterson, [368]-[369]. PET acquisition creates artifacts, and body positioning during “natural breathing” may make PET incompatible with CT images collected under typical “unnatural or cramped” conditions. Weese, ¶¶[0047]-[0051], [0062]; Peterson, [369]. Weese accounts for motion when merging CT and PET, for which Wainer’s gating provides a suitable option. Weese, ¶[0062]; Peterson, [369].

Weese even teaches CT gating by extracting I2 and I3 from sequence IS at specific motion states “using *known methods*.” Weese, ¶¶[0062], [0079], Figs. 1-2; Peterson, [370]. Known methods included gating. Peterson, [370]; §V. It would have been obvious to apply gating for PET given Weese’s need to match motion states before fusion. Peterson, [370]-[371]; Weese, ¶¶[0020]-[0022], [0033], [0071]-[0080], Figs. 1-2; *see Boston Sci.*, 554 F.3d at 991.

It would have been obvious to use Wainer's CT gating to better match motion states. Peterson, [371]; Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. Wainer calls this "preferable" because it better synchronizes images and facilitates registration. Wainer, 3:33-60, 4:56-61, 8:38-9:20. A gated transmission image can be "automatically registered to its corresponding gated emission image, since most of the misalignment between the two images is caused by body rhythms." Wainer, 3:56-60. Gating structural and functional images would have been obvious to achieve these benefits and meet Weese's goal. Peterson, [371].

Wainer's functional image gating also solves a problem that Weese poses by using a sensor-based approach, consistent with Weese. Peterson, [372]. Weese focuses unsharp PET images to a corresponding motion state of a CT image. *Id.*; Weese, ¶¶[0020]-[0022], [0033], [0071]-[0080], Figs. 1-2. Focusing "is possible when the motion leading to the unsharp representation *is known*," and Weese uses a motion model to "*know*[]" that motion. Weese, ¶[0022]; Peterson, [372]. Weese derives the motion model from sensor data that *knows* an "actual motion process." Weese, ¶¶[0031], [0057], [0065]; Peterson, [372]. POSITAs would have seen Wainer's gating as obvious in Weese's system because it provides the sensor-based motion knowledge Weese seeks. Peterson, [372]; Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6.

POSITAs would have found it obvious to sharpen PET and align images to motion states with Wainer's gating. Peterson, [373]-[374]; Weese, ¶¶[0022], [0077]-[0080]; Wainer, 3:33-60, 8:38-9:20, Fig. 6; §V. Weese already uses a known "focusing algorithm" partially derived from CT data. Weese, ¶¶[0033], [0063]-[0067], [0077], Figs. 1-3. Yet CT data are collected under different conditions at different times and even from different instruments than PET data, leading to artifacts upon fusion. Weese, ¶¶[0010], [0072]-[0080]; Peterson, [373]-[374]. Wainer and numerous studies showed gating improves representation of motion states and alignment when combining. Wainer, 3:33-60, 8:38-59; Peterson, [374].

POSITAs also would have looked to Wainer to reduce "smearing" with simultaneous cardiac and respiratory gating. Peterson, [375]; Wainer, 1:10-15, 2:3-21, 3:33-60, 8:38-9:20, Fig. 6; Weese, ¶¶[0009], [0049]-[0051], [0062]-[0063], [0065], Fig. 4; Peterson, [375]. These body rhythms occur at different timescales, a problem Wainer's dual gating solves. Peterson, [375].

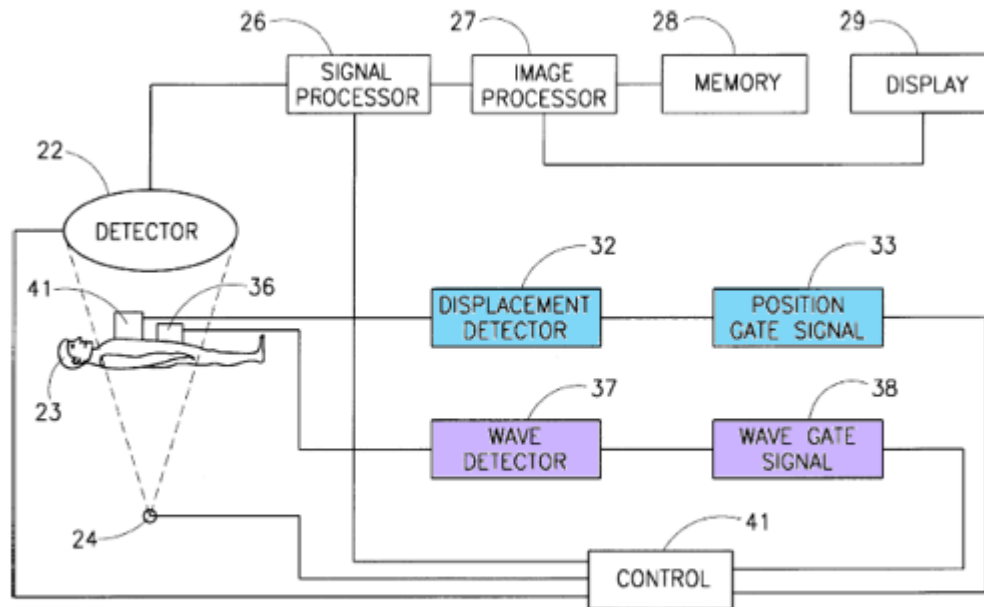


FIG. 6

**Wainer, Fig. 6**

POSITAs would have had success implementing the combination. Peterson, [376]. Wainer's gating achieves the result Weese seeks through "focusing"—representing one motion state. Weese, ¶¶[0022], [0031], Figs. 1-2. Weese already uses the hardware needed for Wainer's gating: radiation source, gantry, detectors, computer, and sensors. Weese, ¶¶[0047]-[0051], [0058], Fig. 6; Wainer, 8:60-9:3, 9:24-31, Fig. 6; Peterson, [376].

**B. Claim 1**

Claim 1 is obvious over Weese and Wainer.

**1. [1p]**

Weese and Wainer renders obvious [1p], as explained for Ground 1. §VIII.B.1; Peterson, [377]-[380].

**2. [1a-i]**

Weese and Wainer renders obvious [1a-i], as explained for Ground 1. §VIII.B.2; Peterson, [381]-[383].

**3. [1a-ii]**

Weese and Wainer renders obvious [1a-ii].

Per Ground 1, Weese discloses [1a-i]. §VIII.B.3; Peterson, [384]-[385].

POSITAs would have found it obvious to employ Wainer's CT gating in Weese's system to improve image information content and match motion states when combining CT-PET. §X.A; Peterson, [386]-[388]. **Sensor 15** measures movements while obtaining **IS**, **I2**, and **I3**. Weese, ¶¶[0053]-[0057].

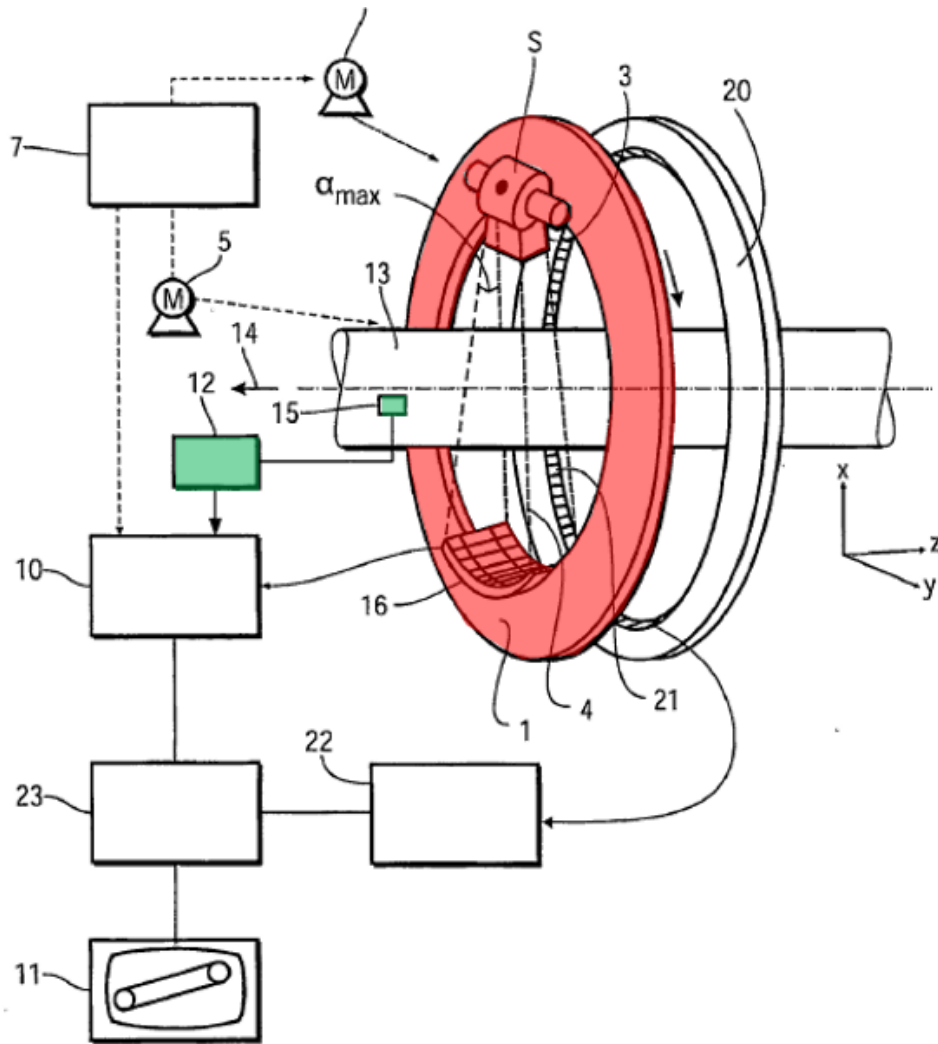


FIG.6

Weese, Fig. 6

This combination groups CT projections into windows associated with breathing and cardiac cycle phases, based on sensor measurements. Peterson, [394]-[395]; §X.A. It was obvious to use Wainer's **respiratory** and **cardiac** sensor systems in Weese's system (already including **sensors**) to achieve gating's benefits, including reduced artifacts and improved image matching. Peterson, [387]; Wainer,

9:6-20, Fig. 6; §X.A. This was a simple, predictable substitution. Peterson, [387]; §X.A.

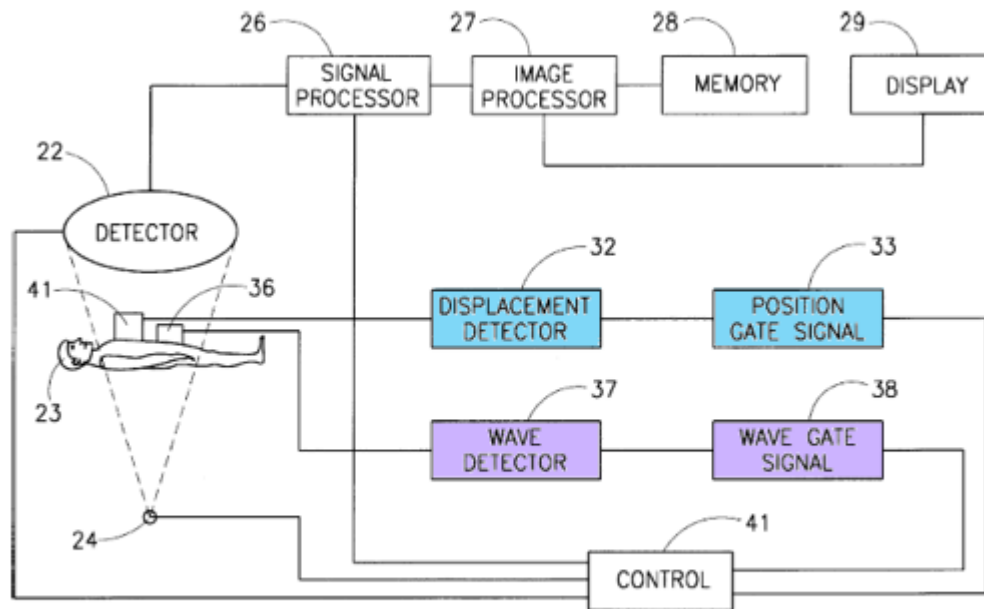


FIG.6

Wainer, Fig. 6

In the combination, position sensor 31 and **displacement detector 32** (“first sensor system”) obtain position measurements (“first measurements”) when collecting CT transmissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; Peterson, [388]; §X.A.

#### 4. [1a-iii]

Weese and Wainer renders obvious [1a-iii].

Per Ground 1, Weese discloses [1a-iii]. §VIII.B.4. Similarly, position sensor 31 and **displacement detector 32** (“first sensor system”) monitor position

independently from transmissions. Peterson, [390]-[392]; Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §X.A.

## **5. [1b]**

Weese and Wainer renders obvious [1b].

The combination uses Wainer's CT gating and bins images by breathing phase using sensor data, which improves motion correction. Wainer, 9:7-20, 3:33-60, 4:56-61, 8:38-59; §§X.A, X.B.2-4; Peterson, [393]-[396]. This discloses the [1b]'s "associating." Peterson, [393]-[396].

## **6. [1c-i]**

Weese and Wainer renders obvious [1c-i].

PET is a "second imaging technique" per [1c-i]. Weese, ¶¶[0047]-[0084], Figs. 1-3. The combination renders obvious "second images" for two reasons. Peterson, [397]-[400]. First, it creates a series of images **10** corresponding to breathing and cardiac phases. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §X.A. Second, references disclose obtaining 2D PET slices. Weese, ¶¶[0053]-[0058], Fig. 6; Wainer, 4:34-55, 6:54-61, 7:10-25.

## **7. [1c-ii]**

Weese and Wainer renders obvious [1c-i].

This combination groups PET projections into windows associated with breathing and cardiac cycle phases, based on sensor measurements. Peterson, [394]-

395]; §X.A. It was obvious to use Wainer's **respiratory** and **cardiac** sensor systems in Weese's system (already including sensors) to achieve gating's benefits, including reduced artifacts and improved image matching. Peterson, [401]-[405]; Wainer, 9:6-20, Fig. 6; §X.A. This was a simple, predictable substitution. Peterson, [401]-[405]; §X.A.

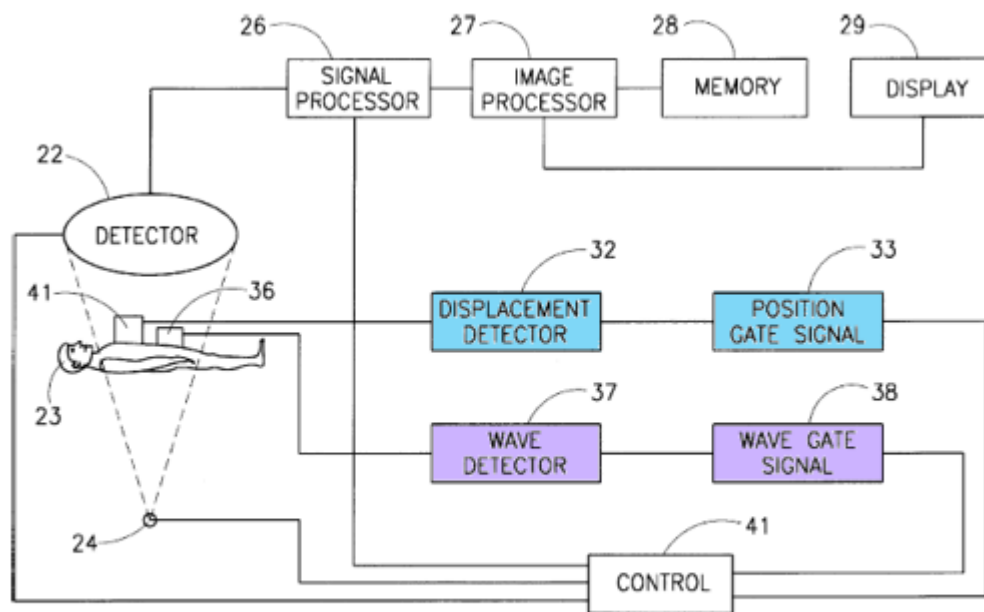


FIG.6

Wainer, Fig. 6

Sensor 36 and **wave detector 37** ("second sensor system") obtain heart-wave data ("second measurements") for PET gating when collecting PET projections. Peterson, [404]; Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6.

## 8. [1c-iii]

Weese and Wainer renders obvious [1c-iii].

Per Ground 1, Weese discloses [1c-iii]. §VIII.B.8. Sensor 36 and **wave detector 37** are a “second sensor system.” Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §X.B.8. They are independent from PET acquisition (“second imaging technique”) because they monitor cardiac cycles, not emissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; Peterson, [406]-[408].

## 9. [1d]

Weese and Wainer renders obvious [1d].<sup>2</sup>

This combination implements Wainer’s position sensor 31 and **displacement detector 32** (respiratory gating), and sensor 36 and **wave detector 37** (cardiac gating). Wainer, 8:40-9:20, Fig. 6; Peterson, [409]-[410]; §X.A. Position sensor 31 yields “first measurements.” §VIII.B.2-4. When gating respiratory and cardiac motion, the combination bins projections by breathing and cardiac phase before reconstructing images, performing [1d]’s “associating.” Peterson, [409]-[412];

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<sup>2</sup> The claim requires using **first** measurements, not second, when associating second images with second movement states. If Patent Owner argues “first” is a typo, the [12d] analysis demonstrates Weese-Wainer renders obvious [1d]. § X.M.9; Peterson, [409].

Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; § X.A. Projection binning was long-known to POSITAs. Peterson, [411].

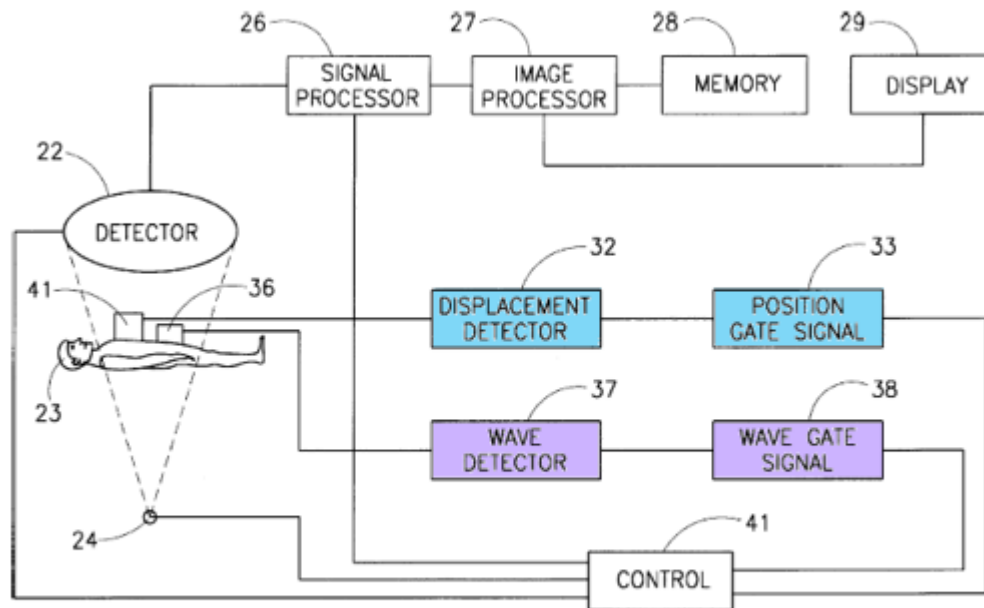


FIG.6

Wainer, Fig. 6

## 10. [1e]

Weese and Wainer renders obvious [1e].

POSITAs would have found it obvious to form dual-gated PET-CT combination images, with a reasonable chance of success. Peterson, [413]-[417]. Both references superimpose structural and functional images. Weese, ¶¶[0076], [0085], Figs. 1-3; Wainer 7:32-41, Figs 4a, 4b, claims 1, 6-7. Images from Weese's combination PET/CT system are already registered, ready to combine. Weese,

¶[0072], Figs. 1-3, 6; Peterson, [416]. Wainer's gated structural and functional images may be "automatically" registered and combined at common motion states. Wainer, 3:56-60, 6:5-52. Weese teaches the benefits of combining images at common motion states. Weese, ¶¶[0076]-[0077], [0079]-[0080], [0083], Figs. 1-3. POSTIAs would have combined dual-gated functional PET images and structural CT images to enhance the quality of information and provide additional diagnostic insights. Peterson, [416].

Weese and Wainer discloses and renders obvious [1e]'s requirement to form "*an* image based on said *plurality* of first images ... and on said *plurality* of second images," two ways: (a) forming a volume image from fused dual-gated functional and structural slices, and (b) superimposing multiple dual-gated functional and dual-gated structural image at different breathing phases. Peterson, [417].

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

This combination renders obvious fused dual-gated PET-CT volume images, rendering obvious [1e].

Both references disclose volume images, and it would have been obvious to use a plurality of dual-gated fused PET-CT images to render a fused volume image. *Id.* Weese teaches PET and CT "volume images" made per "known" techniques. Weese, ¶¶[0002], [0026], [0048], [0058], [0061]; §VIII.B.6.a. Wainer discloses

stacking 2D slices to form structural and functional 3D volume images, which was long known. Wainer, 6:53-7:32; Peterson, [420]; §V. Wainer motivates making 3D volume images so “the attending doctor will not have to work directly with image slices.” Wainer, 7:26-31; Peterson, [420].

POSITAs would have found it obvious to rely on Weese’s and Wainer’s teachings to create volume images from fused, dual-gated structural and functional slices. Peterson, [418]-[421].

**b. Weese-Wainer renders obvious fusing dual-gated PET images and dual-gated CT images at different time points, per [1e]**

Weese-Wainer renders obvious superimposing dual-gated PET and dual-gated CT images at different time points, per [1e]. Peterson, [422]-[426]; Weese, ¶¶[0076], [0085], Figs. 1-3 (e.g., I7, I8, I9); Wainer 7:32-49, Figs 4a, 4b, claims 1, 6-7.

Wainer processes and superimposes images to track radiotracer distribution over time. Wainer, 4:8-14, 5:3-14, 7:32-49, Fig. 4A-4B. “Processing” includes image subtraction, superposition, outlining, and coloring, and Wainer flexibly teaches “simultaneous processing and viewing of *several* images at once.” Wainer, 7:32-49; Peterson, [425]. POSITAs would have found it obvious to superimpose structural and functional dual-gated images. Peterson, [425]-[426]. Before combining images different timepoints, Wainer registers them to account for

position changes. Wainer, 5:32-49; Peterson, [426]. Registration facilitates functional image combination and radiotracer tracking. Wainer, 5:50-6:9; Peterson, [424]-[426].

An image formed by superimposing dual-gated functional images registered to different dual-gated structural images are based on: “first images,” “first measurements,” “first movement states,” “second images,” “second measurements,” and “second movement states,” per [1e]. Peterson, [426].

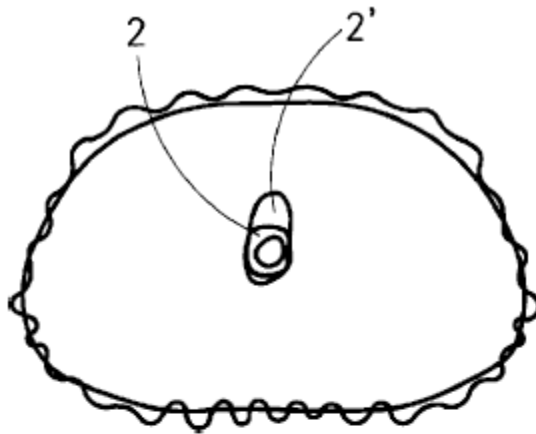


FIG. 4A

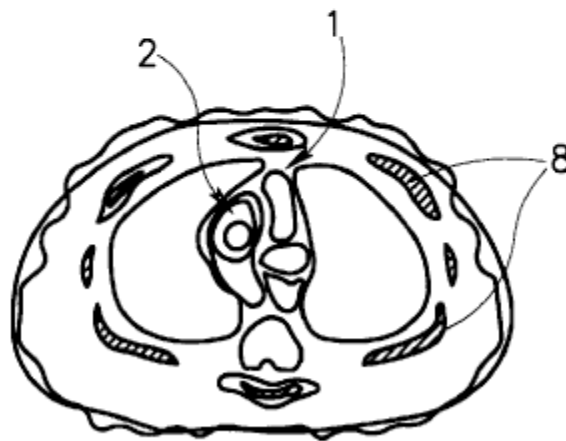


FIG. 4B

**Wainer, Figs. 4A-4B**

**11. [1f]**

Weese and Wainer renders obvious [1f]. Peterson, [427]. CT is a first imaging technique, while PET is a second, different technique. *Id.*; §§X.B.2-VIII.B.4, X.B.6-VIII.B.8.

**C. Claim 2**

Weese and Wainer renders obvious claim 2.

The combination time-synchronizes CT and PET images into different bins based on respiratory phase cardiac phases, including comparing first and second movement states (respiratory and cardiac states). Peterson, [428]-[430]; Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §X.A. Such gating was long-known and obvious. Peterson, [429].

**D. Claim 3**

Weese and Wainer renders obvious claim 3.

In the combination, CT images are “first images,” “reconstructed” from X-ray data, while PET images are a “second images,” “reconstructed” from projections P1. Weese, ¶¶[0047]-[0084]; Peterson, [431]-[433]; §§X, X.B.2-4, X.B.6-8.

**E. Claim 4**

Weese and Wainer renders obvious claim 4.

Registration is spatial synchronization, which was well-known. Peterson, [435]; Ex-1001, 3:54-61. The '353 patent admits synchronization “is not innovative.” Ex-1001, 3:54-61.

Weese and Wainer teach the importance of registration before fusing structural and functional images. Peterson, [436]; 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. §§X.A-X.B. Wainer registers gated images before combining structural and functional images, including when combining images from different timepoints. Wainer, 3:33-60, 4:56-61, 5:50-6:9, 7:32-49, 8:38-9:20; Peterson, [437]. Wainer’s registration facilitates image combination and radiotracer tracking. Wainer, 5:50-6:9; Peterson, [437]. Weese likewise discloses registration before combination. Weese, ¶¶[0072]-[0075]; Peterson, [438].

The combination renders obvious superimposing dual-gated PET-CT images. §X.B.10; Peterson, [439]. It would have been obvious in the combination to register dual-gated PET-CT images before creating superimposed images, rendering obvious claim 4. Peterson, [439].

#### **F. Claim 5**

Weese and Wainer renders obvious claim 5.

In the combination, CT is a “radiation attenuation technique,” while PET is a “radiation emission technique.” Weese, ¶¶[0047]-[0084]; §§X.A, X.B.2-4, X.B.6-8. Peterson, [440]-[441].

#### **G. Claim 6**

Weese and Wainer renders obvious claim 6.

The combination registers dual-gated images. §X.E. Dual-gated images are formed using “first measurements” and “second measurements” from respiratory and cardiac sensor systems. §§X.B.2-4- X.B.6-8. Image registration is spatial-

synchronization. §X.E. Accordingly, by registering dual-gated PET-CT images before combining images, Weese-Wainer renders obvious claim 6. Peterson, [443]-[444].

## **H. Claim 7**

Weese and Wainer renders obvious claim 7 two ways. Peterson, [445]-[454].

### **1. Registration**

The combination's registration renders obvious claim 7. §§X.E, X.G; Peterson, [446].

- Registration is a mathematical coordinate transformation, creating “displacement fields.” Weese, ¶¶[0073]-[0074]; Ex-1009, 1610-11; Wainer, 7:50-8:37; Peterson, [446].
- Registration “correspond[s] to “first” and “second measurements” from sensors because it is based on dual-gated images. §§X.E, X.G; Peterson, [446].
- Registration “correspond[s]” to “first” and “second images” because it applies to structural and functional images. Weese, ¶[0075]; Wainer, 5:50-6:9, 7:50-8:37; §§X.E, X.G; Peterson, [446].

## 2. Focusing gated images

It was obvious to focus the combination's gated PET images with M2 ("displacement fields"). Weese, ¶¶[0063]-[0067]; §VIII.H; Peterson, [447]-[454].

While Weese-Wainer's dual-gating reduces motion artifacts, some remain because motion occurs within a gated phase. Wainer, 3:33-60, 4:56-61, 8:38-49; Peterson, [448]-[449]; §X.A; Ex-1008, 698. POSITAs would have gated PET images with fewer phases than CT to avoid long acquisition times, resulting in some blurring in PET images. Peterson, [450]; Ex-1008, 453, 698; Ex-1011, 368; Ex-1016, 589; Ex-1021.

Weese solves this problem: sharpening blurred PET images with motion model M2. Weese, Abstract, ¶¶[0004], [0018]-[0035], [0052], [0077]-[0083], Figs. 1-2; Peterson, [450]. POSITAs would have focused Weese-Wainer's gated PET images with M2 to achieve the precision and quality Weese and Wainer seek. Peterson, [451]-[453]; Weese, Abstract, ¶¶[0004], [0018]-[0035], [0052], [0083]; Wainer, 3:33-60, 4:56-61, 8:38-49. This was obvious because the combination includes the same features that Weese uses to generate M2 and focus images: I2, I3, and sensors. Weese, ¶¶[0063]-[0067]; §§VIII.B, X.A; Peterson, [452]. And differently gated PET and CT images would be combined at the same motion state, a benefit both references identify. Peterson, [453]; §X.B.10; Wainer, 3:56-60, 6:5-52; Weese, ¶¶[0071]-[0083], Figs. 1-3.

Then, as with Weese alone, constructing and applying M2 renders claim 7 obvious over Weese and Wainer. §VIII.H; Peterson, [447]-[454].

### **I. Claim 8**

Weese and Wainer renders obvious claim 8.

It would have been obvious to use Weese's motion vectors to focus coarsely-gated PET images before fusing with finely-gated CT images. §X.H.2; Peterson, [455]-[456]. This "combin[es]" motion vectors because it accounts for displacement between phases. Peterson, [456]; Ex-1001, 7:24-29; §VIII.I.

### **J. Claim 9**

Weese and Wainer renders obvious claim 9.

Weese's motion vector fields are displacement fields. Weese, ¶¶[0063]-[0068]; §§VIII.H, X.H; Peterson, [458]. They are based on movement estimates between "first images" **I2** and **I3** extracted from sequence **IS** using "first measurements" from **sensor 15**. §VIII.H; Peterson, [459]. Weese, ¶¶[0031], [0057]-[0083]; §§VII.A, VIII.A, VIII.B.3, VIII.H.

Position sensor 31 and **displacement detector** ("first sensor system") obtain "first measurements" for CT gating when collecting transmissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §§X.A, X.B.2-4. The combination bases motion vectors on dual-gated CT images, which estimates object movement. §X.H. Weese-Wainer accordingly discloses and renders obvious "estimating movement" based on

“first images” and “first measurements” to form displacement fields, per claim 9. Peterson, [459].

Further, Weese’s partially derives motion vectors from **S1**’s “second measurements” during PET acquisition. Weese, ¶¶[0065]-[0067]; §§VIII.B.7, VIII.B.10. Wainer’s sensor 36 and **wave detector 37** (“second sensor system”) plays the role of **S1** in the combination. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §§X.A, X.B.6-8. Weese-Wainer accordingly discloses and renders obvious “estimating movement” based on “second images” and “second measurements,” to form displacement fields, per claim 9. Peterson, [460].

#### **K. Claim 10**

Weese and Wainer renders obvious claim 10.

**S1** obtains “actual motion” data for generating F1 when forming motion vectors. Weese, ¶¶[0065]-[0067]; Peterson, [461]-[462]; §§X.H. F1 involves a “reference time”  $t$ , corresponding to motion states. Weese, ¶¶[0065]-[0067], Figs. 4-5; Peterson, [462].

#### **L. Claim 11**

Weese and Wainer renders obvious claim 11.

The combination uses different **respiration** and **cardiac** sensors. Wainer, 9:6-20, Fig. 6; §§X.B.2-4, X.B.6-8; Peterson, [463]-[464].

**M. Claim 12**

**1. [12p]**

Weese-Wainer renders obvious [12p], as discussed for [1p]. §X.B.1; Peterson, [465].

**2. [12a-i]**

Weese-Wainer renders obvious [12a-i].

[12a-i] is a means-plus-function term, and Weese-Wainer performs its function. §§VI.1, X.B.2; Peterson, [466]-[467].

The corresponding structure includes an attenuation or emission radiation source and detector, gantry, processor, and memory. §VI.1. Weese discloses it. §§VIII.M.2, X.B.2; Peterson, [468]-[469]. The combination implements Weese's structures, so Weese-Wainer renders obvious [12a-i]. §§X.A, X.B.2; Peterson, [468]-[469].

**3. [12a-ii]**

Weese-Wainer renders obvious [12a-ii].

[12a-ii] is a means-plus-function term, and Weese-Wainer performs its function. §§VI.2, X.B.3; Peterson, [470]-[471].

The corresponding structure includes a breathing, pressure, or electrocardiogram sensor. §VI.2. Weese-Wainer renders it obvious; position sensor 31 is a breathing sensor. §§X.A, X.B.3; Peterson, [472].

**4. [12a-iii]**

Weese-Wainer renders obvious [12a-iii], as discussed for [1a-iii]. §X.B.4; Peterson, [473].

**5. [12b]**

Weese-Wainer renders obvious [12b].

[12b] contains a means-plus-function term, and Weese-Wainer renders obvious its function. §§VI.3, X.B.5; Peterson, [474]-[475].

The corresponding structure presumably includes a computer programmed to perform the associating. §VI.3. Weese and Wainer each disclose it. Peterson, [476]-[477]. Weese's methods are computerized. *Id.*; §VIII.M.5; Wainer's methods are also computerized. Wainer, 6:65-67, 7:26-31, 7:41-49, 9:1-20; Peterson, [477]. Accordingly, Weese-Wainer renders obvious [12b]. §§X.A, X.B.5; Peterson, [474]-[477].

**6. [12c-i]**

Weese-Wainer renders obvious [12c-i].

[12c-i] is a means-plus-function term and Weese-Wainer performs its function. §§VI.4, X.B.6; Peterson, [478]-[479].

The corresponding structure includes an attenuation or emission radiation source, detector, gantry, processor, and memory. §VI.4. Weese discloses it, as explained. §VIII.B.6; Peterson, [480]-[481]. The combination implements Weese's

structures, so Weese-Wainer renders obvious [12c-i]. §§X.A, X.B.6; Peterson, [480]-[481].

**7. [12c-ii]**

Weese-Wainer renders obvious [12c-ii].

[12c-ii] is a means-plus-function term, and Weese-Wainer performs its function. §§VI.5, X.B.7; Peterson, [482]-[483].

The corresponding structure includes a breathing, pressure, or electrocardiogram sensor. §VI.5. Weese-Wainer renders it obvious; cardiac sensor 36 is an electrocardiogram sensor. §§X.A, X.B.7; Peterson, [484].

**8. [12c-iii]**

Weese-Wainer renders obvious [12c-iii]. §X.B.8; Peterson, [485].

**9. [12d]**

Weese-Wainer renders obvious [12d].

[12d] contains a means-plus-function term, and Weese-Wainer performs its function. §§VI.6, X.B.9.

Further, [12d] requires “associating ... second images with second movement states ... determined by the *second* measurements,” while [1d] requires “associating ... using the *first* measurements.” The same processes that render obvious [1d] also disclose [12d]’s function because they group projections by cardiac *and* respiratory

phase. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §§X.A, X.B.9; Peterson, [486]-[488].

The corresponding structure presumably includes a computer programmed to perform the associating. §VI.6. Weese-Wainer renders it obvious because both references implement computerized methods. §§X.A, X.M.5, X.B.9; Peterson, [489]-[490].

#### **10. [12e]**

Weese-Wainer renders obvious [12e].

[12e] is a means-plus-function term, and Weese-Wainer performs its function. §§VI.7, X.B.10; Peterson, [491]-[492].

The corresponding structure presumably includes a computer programmed to perform the forming. §VI.7. Weese-Wainer renders it obvious both references implement computerized methods. §§X.M.5, X.B.10; Peterson, [493]-[494].

#### **11. [12f]**

Weese-Wainer renders obvious [12f], as discussed for [1f]. §X.B.11; Peterson, [495].

#### **N. Claim 13**

Weese-Wainer renders obvious claim 13.

Claim 13 is a means-plus-function term, and Weese-Wainer performs its function. §§VI.8, X.D; Peterson, [496]-[497].

The corresponding structure presumably includes a computer programmed to perform the forming. §VI.8. Weese-Wainer renders it obvious because both references implement computerized methods. §§X.M.5, X.D; Peterson, [498]-[499].

**O. Claim 14**

Weese-Wainer renders obvious claim 14, as discussed for claim 5. §X.F; Peterson, [500].

**P. Claim 15**

Weese-Wainer renders obvious claim 15.

Claim 15 is a means-plus-function term, and Weese-Wainer performs its function. §§VI.9, X.H; Peterson, [501]-[502].

The corresponding structure presumably includes a computer programmed for forming displacement fields. §VI.9. Weese-Wainer renders it obvious because both references implement computerized methods. §§X.M.5, X.H; Peterson, [503]-[504].

**Q. Claim 16**

Weese-Wainer renders obvious claim 16.

Claim 16 is a means-plus-function term, and Weese-Wainer performs its function. §§VI.10, X.I; Peterson, [505]-[506].

The corresponding structure presumably includes a computer programmed for combining displacement fields. §VI.10. Weese-Wainer renders it obvious because

both references implement computerized methods. §§X.M.5, X.I; Peterson, [507]-[508].

**R. Claim 17**

Weese discloses claim 17.

Claim 17 is a means-plus-function term, and Weese-Wainer performs this function. §§VI.11, X.J; Peterson, [509]-[510].

The corresponding structure presumably includes a computer programmed for estimating movement based on images and measurements. §VI.11. Weese-Wainer renders it obvious because both references implement computerized methods. §§X.M.5, X.J; Peterson, [511]-512].

**S. Claim 18**

Weese-Wainer renders obvious claim 18, as discussed for claim 10. §X.K; Peterson, [513].

**XI. GROUND 4 (WAINER)**

**A. Claim 1**

Claim 1 is obvious over Wainer.

**1. [1p]**

Wainer discloses [1p].

Wainer forms images of moving objects when acquiring, displaying, and combining SPECT, SPTCT, STET, and CT images of patients. Wainer, Abstract, 1:10-61, 2:24-53, 6:53-55, 7:32-49, 8:60-9:20, Figs. 1-6; Peterson, [514]-[517]. The patient and organs are objects experiencing “body rhythms and motions.” Wainer, 3:33-60, 4:56-61, 8:38-9:20.

## 2. [1a-i]

Wainer discloses [1a-i].

Wainer obtains structural images (e.g., CT or SPTCT)—a “first imaging technique”—as a plurality of slices—“first images.” *E.g.*, Wainer, Abstract, 2:29-3:60, 4:34-55, 6:53-7:31, Fig. 2A; Peterson, [518]-[519].

Wainer uses conventional gating of structural images, grouping projections into time bins associated with motion states to reduce smearing and facilitate registration. Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6; Ex-1008, 452, 696-698; §V. Gated structural images also disclose “first images.” Peterson, [520]-[521].

## 3. [1a-ii]

Wainer discloses [1a-ii].

Wainer employs sensors for simultaneous respiratory and cardiac gating. Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6; §XI.A.2. Position sensor 31 and **displacement detector 32** (“first sensor system”) obtain position data (“first

measurements”) while collecting structural images. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; Peterson, [522]-[527].

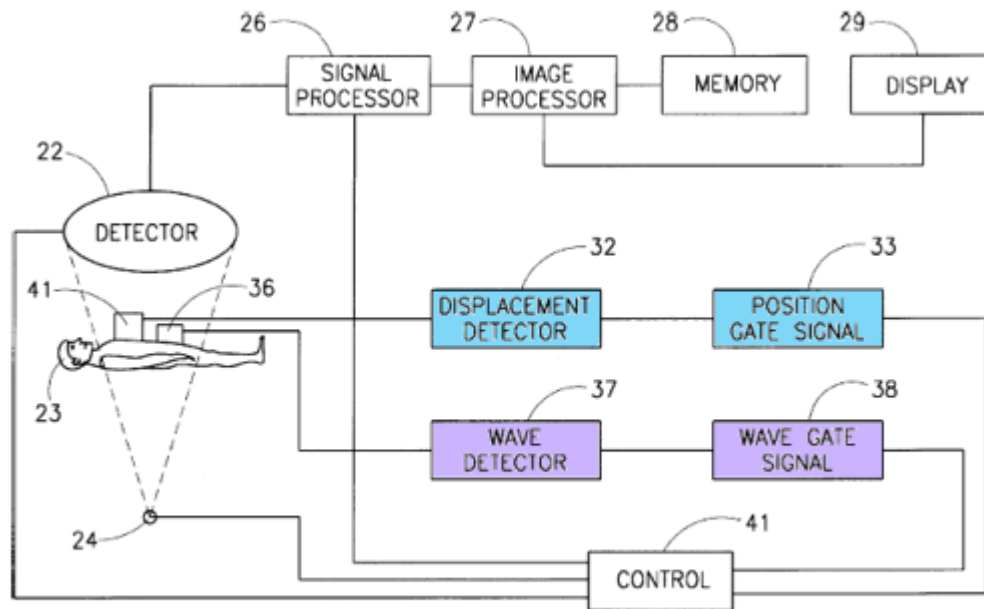


FIG.6

Wainer, Fig. 6

#### 4. [1a-iii]

Wainer discloses [1a-iii].

Position sensor 31 and **displacement detector 32** (“first sensor system”) monitor position independently from transmissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; Peterson, [528]-[530].

#### 5. [1b]

Wainer discloses [1b].

Wainer gates CT images, which bins projections into windows corresponding to breathing cycle phases based on position measurements, disclosing [1b]’s “associating.” Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6; §§XI.A.2-XI.A.4; Peterson, [531]-[533].

## 6. [1c-i]

Wainer discloses [1c-i].

Wainer obtains functional 2D slice images (e.g., STET, SPECT), per [1c-i]. *E.g.*, Wainer, Abstract, 2:29-3:60, 4:34-55, 6:53-742, Fig. 4A; Peterson, [534]-[537]. Wainer uses conventional gating of structural images, grouping projections into time bins associated with motion states to reduce smearing and facilitate registration. Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6; Ex-1008, 452, 696-698. Gated functional images also disclose [1c-i]. Peterson, [534]-[537].

## 7. [1c-ii]

Wainer discloses [1c-ii].

Wainer employs sensors for simultaneous respiratory and cardiac gating. Wainer, 3:33-60, 4:56-61, 8:38-59, 8:60-9:20, Fig. 6; §XI.A.2. Sensor 36 and **wave detector 37** (“second sensor system”) obtains waves (“second measurements”) while collecting functional emissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; Peterson, [538]-[542].

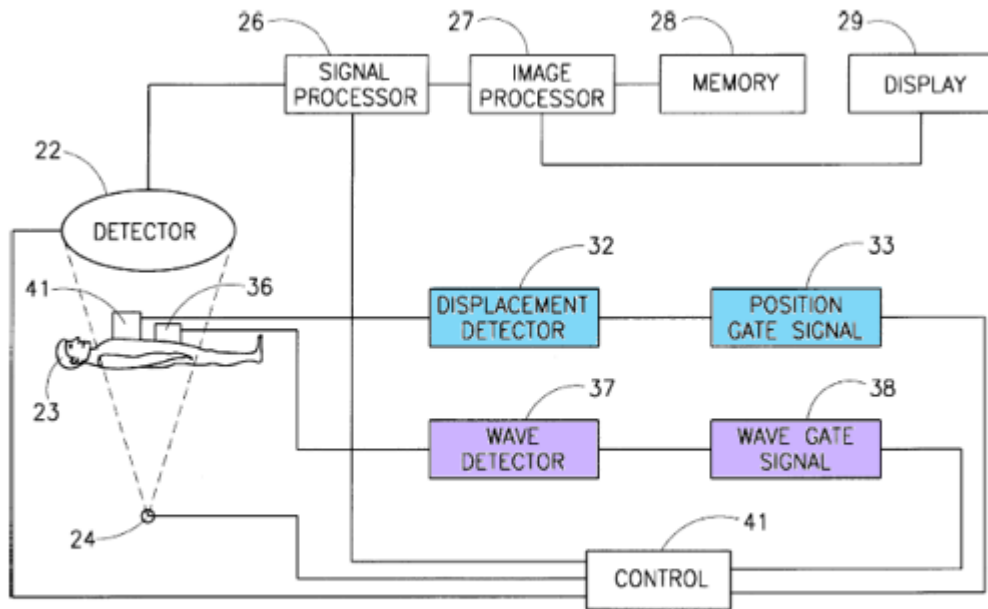


FIG.6

Wainer, Fig. 6

8. [1c-iii]

Wainer discloses [1c-iii].

Sensor 36 and **wave detector 37** are a “second sensor system” that monitors waves independently from emissions. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6. §XI.A.6; Peterson, [543]-[545].

9. [1d]

Wainer discloses [1d].<sup>3</sup>

Wainer gates functional images to cardiac and respiratory cycles, which bins projections by breathing phase based on position (“first measurements”), disclosing [1d]’s “associating.” Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §§XI.A.2-XI.A.4, XI.L.6-XI.L.8; Peterson, [546]-[549].

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<sup>3</sup> [1d] uses *first* measurements, not *second*, when associating second images with second movement states. If Patent Owner argues “first” is a typo, the [12d] analysis demonstrates Wainer discloses [1d]. § XI.L.9; Peterson, [546].

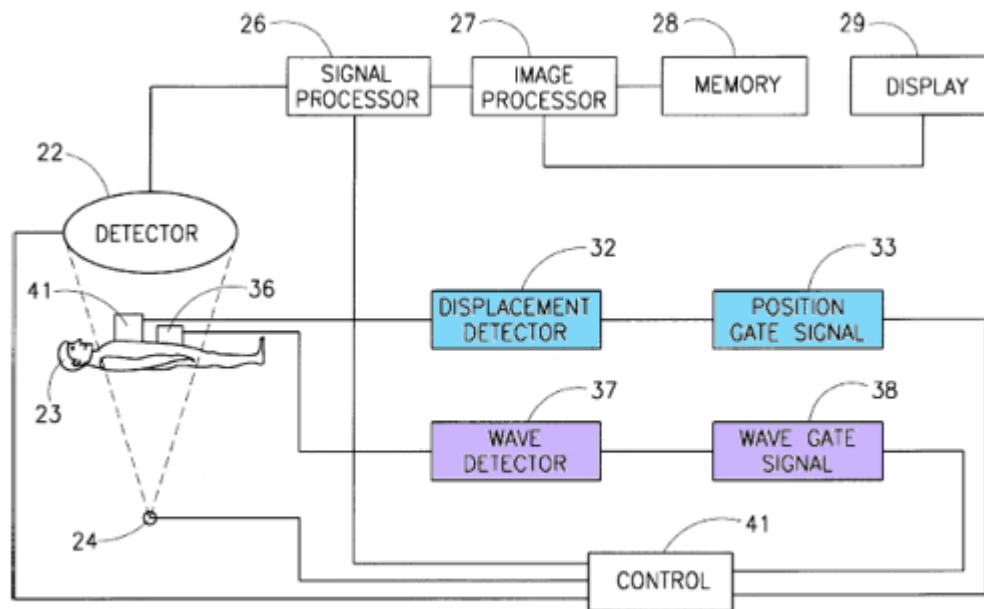


FIG.6

Wainer, Fig. 6

10. [1e]

Wainer discloses and render obvious [1e].

Wainer creates dual-gated structural and functional images to reduce “smearing.” Wainer, 3:40-41, 8:38-39, 8:60-62, Fig. 6; Peterson, [552]; §§XI.A.2-XI.A.4, XI.A.6-XI.A.8. Wainer fuses (e.g., superimposes) dual-gated images. Wainer, 3:56-60, 6:5-52, 7:32-41, Figs 4a, 4b, claims 1, 6-7. Fusing renders obvious [1e]. Peterson, [550]-[562].

Wainer discloses and renders obvious forming “*an* image based on said *plurality* of first images ... and on said *plurality* of second images,” per [1e], two ways: by forming (a) a volume image from fused dual-gated functional and structural

slices, and (b) a fused image from multiple dual-gated functional and dual-gated structural images at different breathing phases. Peterson, [553].

**a. Wainer teaches fused dual-gated structural and functional volume images, which discloses and renders obvious [1e]**

Wainer stacks 2D slices to form structural and functional 3D volume images. Wainer, 6:53-7:32; Peterson, [554]-[555]. Slice-by-slice volume rendering was long known. Peterson, [555]; §V. Wainer further motivates making 3D volume images so a doctor avoids “work[ing] directly with image slices.” Wainer, 7:26-31; Peterson, [555]. POSITAs would have found it obvious to use Wainer’s teachings to create a volume image from fused, dual-gated structural and functional slices. Peterson, [554]-[556].

**b. Wainer discloses and renders obvious fusing dual-gated functional and structural images at different time points, per [1e]**

Wainer processes and superimposes images to track radiotracer distribution over time. Wainer, 4:8-14, 5:3-14, 7:32-49, Fig. 4A-4B. “Processing” includes image subtraction, superposition, outlining, and coloring, and Wainer flexibly teaches “simultaneous processing and viewing of *several* images at once.” Wainer, 7:32-49; Peterson, [557]-[560]. POSITAs would have found it obvious to superimpose structural and functional dual-gated images. Peterson, [557]-[562]. Before combining images different timepoints, Wainer registers them to account for

position changes. Wainer, 5:32-49; Peterson, [562]. Registration facilitates functional image combination and radiotracer tracking. Wainer, 5:50-6:9; Peterson, [562].

An image formed by superimposing dual-gated functional images registered to different dual-gated structural images are based on: “first images,” “first measurements,” “first movement states,” “second images,” “second measurements,” and “second movement states,” per [1e]. Peterson, [562].

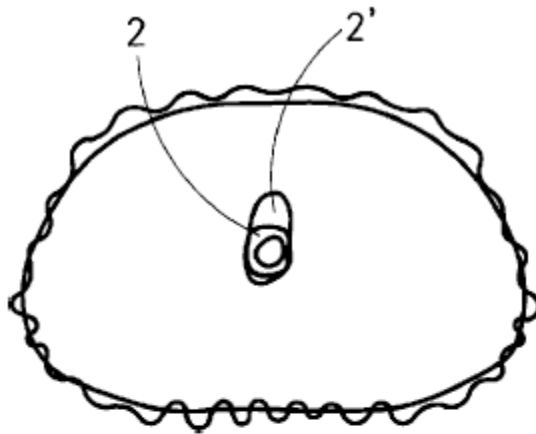


FIG. 4A

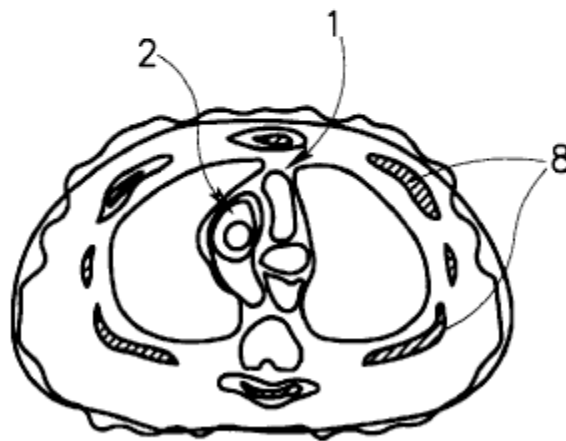


FIG. 4B

**Wainer, Figs. 4A-4B**

**11. [1f]**

Wainer discloses [1f]. Structural imaging (CT, SPTCT), is a first technique, while functional imaging (STET, SPECT) is a second, different technique. Peterson, [563]; §§X.B.2-4, X.B.6-8.

**B. Claim 2**

Wainer discloses claim 2.

Wainer time-synchronizes CT and PET images into windows by respiratory and cardiac phase, which involves comparing first and second movement states (respiratory and cardiac states), as was long known. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; Peterson, [564]-[566].

**C. Claim 3**

Wainer discloses claim 3.

Wainer's structural images (CT or SPTCT) are "first images" reconstructed from transmission data, while Wainer's functional images (STET or SPECT) images are "second images" reconstructed from emission data. Wainer, Abstract, 2:29-3:60, 7:33-42, Fig. 4A; §§XI.A.2, XI.A.6. Peterson, [567]-[569].

**D. Claim 4**

Wainer discloses claim 4.

Registration, which was well-known, is spatial synchronization. Peterson, [570]; Ex-1001, 3:54-61. The '353 patent admits synchronization "is not innovative." Ex-1001, 3:54-61.

Wainer discloses registering before combining structural and functional gated images, per claim 4. Wainer, 3:33-60, 4:56-61, 5:50-6:9, 7:32-49, 8:38-9:20; Peterson, [570]-[573].

**E. Claim 5**

Wainer discloses claim 5.

Wainer's structural images (CT or SPTCT) are formed by radiation attenuation techniques, while its functional images (STET or SPECT) images are formed by radiation emission techniques. Wainer, Abstract, 2:29-3:60, 7:33-42, Figs. 2A, 4A; §§XI.A.2; XI.A.6. Peterson, [574]-[576].

**F. Claim 6**

Wainer discloses claim 6.

Wainer's forms dual-gated images using "first measurements" and "second measurements" from respiratory and cardiac sensors. §§XI.A.2-XI.A.4 - XI.A.6-XI.A.8. Registration is spatial synchronization. §XI.D. By registering before combining dual-gated images, Wainer discloses claim 6. Peterson, [577]-[578].

**G. Claim 7**

Wainer renders obvious claim.

Registration mathematically transforms images, disclosing and rendering obvious "displacement fields." Wainer, 7:33-34, 7:50-8:37; Peterson, [579]-[583]. Registration "correspond[s] to "first" and "second measurements" from respiratory and cardiac sensor data, per claim 7. §§XI.D, XI.F; Peterson, [581]. Registration also "correspond[s]" to "first images" and "second images," per claim 7 because

Wainer's mathematical operators ("displacement fields") apply to structural or functional images. Wainer, 5:50-6:9, 7:50-8:37; Peterson, [582].

#### **H. Claim 8**

Wainer renders obvious claim 8.

Registration discloses displacement fields. §XI.G. Wainer's registration accounts for displacement between phases, which renders obvious "combining" displacement fields. Peterson, [584]-[585]; Ex-1001, 7:24-29; §XI.G.

#### **I. Claim 9**

Wainer renders obvious claim 9.

Wainer's mathematical registration maps features of different images and teaches "displacement fields." Wainer, 7:33-34, 7:50-8:37; Peterson, [586]-[588]; §XI.G. As explained, Wainer superimposes dual-gated functional images registered to different dual-gated structural images. Wainer, 4:8-11, 7:32-41, Fig. 4A; §XI.A.10.b. When registering before combining images, Wainer discloses and renders obvious "estimating movement of the mobile object" based on "first" and "second" images and measurements to form displacement fields, per claim 9, because Wainer bases registration and fusion on two functional images, two structural images, and cardiac and respiratory sensor measurements. Peterson, [586]-[588].

**J. Claim 10**

Wainer discloses claim 10.

Wainer gates images to breathing and cardiac phases, which are “reference time[s],” per claim 10. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §§XI.A.2-XI.A.4, XI.A.6-XI.A.8; Peterson, [589]-[590]. When determining transformations to register gated images, Wainer forms movement estimates relative to a phase, which discloses claim 10. Peterson, [589]-[590].

**K. Claim 11**

Wainer discloses claim 11.

Wainer uses different respiratory and cardiac sensors. Wainer, 9:6-20, Fig. 6; §§XI.A.2-XI.A.4 - XI.A.6-XI.A.8; Peterson, [591]-[592].

**L. Claim 12**

**1. [12p]**

Wainer discloses and renders obvious [12p], as discussed for [1p]. §XI.A.1; Peterson, [593].

**2. [12a-i]**

Wainer discloses [12a-i].

[12a-i] is a means-plus-function term, and Wainer discloses its function. §§VI.1, XI.A.2; Peterson, [594]-[595].

The corresponding structure includes an attenuation or emission radiation source and detector, gantry, processor, and memory. §VI.1. Wainer's conventional system discloses this structure because Wainer obtains CT or SPTCT images, which requires these features. Wainer, 6:5-18; §§V, XI.A.2; Peterson, [596]-[597].

**3. [12a-ii]**

Wainer discloses [12a-ii].

[12a-ii] is a means-plus-function term, and Wainer discloses its function. §§VI.2, XI.A.3; Peterson, [598]-[599].

The corresponding structure includes a breathing, pressure, or electrocardiogram sensor. §VI.2. Wainer's position sensor 31 is a breathing sensor. §XI.A.3; Peterson, [600].

**4. [12a-iii]**

Wainer discloses [12a-iii], as discussed for [1a-iii]. §XI.A.4; Peterson, [601].

**5. [12b]**

Wainer discloses [12b].

[12b] contains a means-plus-function term, and Wainer discloses its function. §§VI.3, XI.A.5; Peterson, [602]-[603].

The corresponding structure presumably includes a computer programmed to perform the associating. §VI.3. Wainer discloses it because Wainer implements

computerized methods. Wainer, 6:65-67, 7:26-31, 7:41-49, 9:1-20; Peterson, [604]-[605]; §XI.A.5.

**6. [12c-i]**

Wainer discloses [12c-i].

[12c-i] is a means-plus-function term, and Wainer discloses its function. §§VI.4, XI.A.6; Peterson, [606]-[607].

The corresponding structure includes an attenuation or emission radiation source, detector, gantry, processor, and memory. §VI.4. Wainer discloses this structure because it was required for its conventional STET (or SPECT) system. Wainer, 1:17-52, 8:38-9:20, Fig. 6; Peterson, [608]-[609]; §§V, XI.A.6.

**7. [12c-ii]**

Wainer discloses [12c-ii].

[12c-ii] is a means-plus-function term, and Wainer discloses its function. §§VI.5, XI.A.7; Peterson, [610]-[611].

The corresponding structure includes a breathing, pressure, or electrocardiogram sensor. §VI.5. Cardiac sensor 36 is an electrocardiogram sensor. §XI.A.7; Peterson, [612].

**8. [12c-iii]**

Wainer discloses [12c-iii], as discussed for [1c-iii]. §XI.A.8; Peterson, [613].

**9. [12d]**

Wainer discloses [12d].

[12d] contains a means-plus-function term, and Wainer discloses its function. §§VI.6, XI.A.9; Peterson, [614]-[616].

[12d] requires “associating ... second images with second movement states ... determined by the *second* measurements,” while [1d] requires “associating ... using the *first* measurements.” The same processes that teach [1d] also teach [12d] because they group projections by respiratory *and* cardiac phase. Wainer, 3:33-60, 4:56-61, 8:38-9:20, Fig. 6; §XI.A.9; Peterson, [616].

[12d]’s structure presumably includes a computer programmed to perform the associating. §VI.6. Wainer’s computerized methods disclose it. §§XI.L.5, XI.A.9; Peterson, [617]-[618].

**10. [12e]**

Wainer discloses [12e]. §XI.A.10.

[12e] is a means-plus-function term, and Wainer discloses its function. §§VI.7, XI.A.10; Peterson, [619]-[620].

The corresponding structure presumably includes a computer programmed to perform [12e]’s method. §VI.7. Wainer’s computerized methods disclose it. §§XI.L.5, XI.A.10; Peterson, [621]-[622].

**11. [12f]**

Wainer discloses [12f], as discussed for [1f]. §XI.A.11; Peterson, [623].

**M. Claim 13**

Wainer discloses claim 13. §XI.C.

Claim 13 is a means-plus-function term, and Wainer discloses its function. §§VI.8, XI.C; Peterson, [624]-[625].

The corresponding structure presumably includes a computer programmed to perform claim 13's method. §VI.8. Wainer implements computerized methods. §§XI.L.5, XI.C; Peterson, [626]-[627].

**N. Claim 14**

Wainer discloses claim 14, as discussed for claim 5. §XI.E; Peterson, [628].

**O. Claim 15**

Wainer renders obvious claim 15. §XI.G.

Claim 15 is a means-plus-function term, and Wainer renders obvious its function. §§VI.9, XI.G; Peterson, [629]-[630].

The corresponding structure presumably includes a computer programmed for forming displacement fields. §VI.9. Wainer's computerized methods disclose it. §§XI.L.5, XI.G; Peterson, [631]-[632].

**P. Claim 16**

Wainer renders obvious claim 16. §XI.H.

Claim 16 is a means-plus-function term, and Wainer renders obvious its function. §§VI.10, XI.H; Peterson, [633]-[634].

The corresponding structure presumably includes a computer programmed for combining displacement fields. §VI.10. Wainer's computerized methods disclose it. §§XI.L.5, XI.H; Peterson, [635]-[636].

**Q. Claim 17**

Wainer renders obvious claim 17. §XI.I.

Claim 17 is a means-plus-function term, and Wainer renders obvious its function. §§VI.11, XI.I; Peterson, [637]-[638].

The corresponding structure presumably includes a computer programmed for estimating movement based on images and measurements. §VI.11 Wainer's computerized methods disclose it. §§XI.L.5, XI.I; Peterson, [639]-[640].

**R. Claim 18**

Wainer discloses claim 18, as discussed for claim 10. §XI.J; Peterson, [641].

**XII. DISCRETIONARY DENIAL IS UNWARRANTED**

Discretionary denial is unwarranted. If Patent Owner disagrees, Petitioner reserves the right to respond.

Petitioner stipulates that, if this Petition is instituted, it will not pursue in district court the grounds identified here or grounds that could reasonably have been raised via IPR.

### **XIII. MANDATORY NOTICES UNDER 37 C.F.R. §42.8**

#### **A. Real Parties-in-Interest**

The real parties-in-interest are Volkswagen Group of America, Inc., Volkswagen AG, and Audi AG.

#### **B. Related Matters**

To the best of Petitioner's knowledge, the '353 patent is involved in *Longhorn Automotive Group LLC v. Volkswagen AG*, 2:24-cv-00933 (E.D. Tex.); *Longhorn Automotive Group LLC v. Mitsubishi Motors Corp.*, 2:24-cv-00685 (E.D. Tex.); *Longhorn Automotive Group LLC v. Mazda Motor Corp.*, 2:24-cv-00686 (E.D. Tex.); *Longhorn Automotive Group LLC v. Volvo Car Corp.*, 2:24-cv-00603 (E.D. Tex.); *Longhorn Automotive Group LLC v. Hyundai Motor Corp.*, 2:24-cv-00554 (E.D. Tex.); *Longhorn Automotive Group LLC v. Nissan Motor Corp.*, 2:24-cv-00397 (E.D. Tex.).

#### **C. Lead and Back-Up Counsel**

| Lead Counsel                                                                                  | Back-up Counsel                                                                                    |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| Elliot C. Cook (Reg. No. 61,769)<br>elliot.cook@finnegan.com<br>Finnegan, Henderson, Farabow, | Alexander Boyer (Reg. No. 66,599)<br>alexander.boyer@finnegan.com<br>Finnegan, Henderson, Farabow, |

|                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Garrett &amp; Dunner, LLP<br/>1875 Explorer Street, Suite 800<br/>Reston, VA 20190-6023<br/>Tel.: 571-203-2700<br/>Fax: 202-408-4400</p> | <p>Garrett &amp; Dunner, LLP<br/>1875 Explorer Street, Suite 800<br/>Reston, VA 20190-6023<br/>Tel.: 571-203-2700<br/>Fax: 202-408-4400</p> <p>Daniel Jordan (Reg. No. 78,038)<br/>daniel.jordan@finnegan.com<br/>Finnegan, Henderson, Farabow,<br/>Garrett &amp; Dunner, LLP<br/>1875 Explorer Street, Suite 800<br/>Reston, VA 20190-6023<br/>Tel.: 571-203-2700<br/>Fax: 202-408-4400</p> <p>Luke MacDonald (Reg. No. 79,064)<br/>luke.macdonald@finnegan.com<br/>Finnegan, Henderson, Farabow,<br/>Garrett &amp; Dunner, LLP<br/>1875 Explorer Street, Suite 800<br/>Reston, VA 20190-6023<br/>Tel.: 571-203-2700<br/>Fax: 202-408-4400</p> |
|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Petitioner consents to electronic service at the following email address:

Finnegan-Longhorn-353IPR@finnegan.com.

#### **XIV. STANDING**

The '353 patent is available for IPR. Petitioner is not barred or estopped.

#### **XV. CONCLUSION**

Petitioner requests institution and cancellation of claims 1-18.

Respectfully submitted,

Dated: May 30, 2025

By: /Elliot C. Cook/

Elliot C. Cook (Reg. No. 61,769)

Lead Counsel

## CLAIM APPENDIX

### Claim 1

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

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

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

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

**[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;

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

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

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

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

[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,

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

**Claim 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.

**Claim 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.

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

**Claim 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.

**Claim 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.

**Claim 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.

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

**Claim 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

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

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

**Claim 12**

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

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

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

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

**[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;

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

**[12c-ii]** means for obtaining a plurality of second measurements

corresponding to movements of the mobile object while obtaining the plurality of second images,

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

**[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

**[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,

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

**Claim 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.

**Claim 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.

**Claim 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.

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

**Claim 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.

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

**CERTIFICATE OF COMPLIANCE**

The undersigned hereby certifies that the foregoing **Petition for *Inter Partes* Review** contains 13,929 words, excluding those portions identified in 37 C.F.R. §42.24(a), as measured by the word-processing system used to prepare this paper.

Dated: May 30, 2025

/Elliot C. Cook/

Elliot C. Cook (Reg. No. 61,769)

Lead Counsel

**CERTIFICATE OF SERVICE**

The undersigned certifies that the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 8,265,353, the associated Power of Attorney, and Exhibits 1001 through 1029 were served on May 30, 2025, by FedEx Priority Overnight® on the correspondence address of record indicated in the Patent Office's Patent Center system for U.S. Patent No. 8,265,353.

Zhong Law, LLC  
51 JFK Parkway, 1<sup>st</sup> Floor West  
Short Hills, NJ 07078

A courtesy copy is also being sent via FedEx Priority Overnight® to  
litigation counsel at:

Alfred R. Fabricant, Esq.  
FABRICANT LLP  
411 Theodore Fremd Ave., Suite 206 South  
Rye, New York 10580

Dated: May 30, 2025

/Mark A. Rosenberger/  
Mark A. Rosenberger  
Case Manager  
Finnegan, Henderson, Farabow,  
Garrett & Dunner, LLP