

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMAZON.COM SERVICES LLC
Petitioner,

v.

SMART SPEAKER LLC
Patent Owner.

Patent No. 11,190,590

Inter Partes Review No. IPR2026-00148

DECLARATION OF HENRY H. HOUH

I, Henry H. Houh, make this declaration in connection with the proceeding identified above.

I. INTRODUCTION

1. I have been retained by counsel for Petitioner Amazon.com Services LLC (“Amazon”) as a technical expert in connection with the proceeding identified above. I submit this declaration in support of Amazon’s Petition for *Inter Partes* Review of United States Patent No. 11,190,590 (“the ’590 patent”).

2. I am being compensated at my normal rate, plus reimbursement for expenses, for my analysis. My compensation does not depend on the content of my opinions or the outcome of this proceeding.

II. EXPERIENCE AND QUALIFICATIONS

3. In formulating my opinions, I have relied upon my knowledge, training, and experience in the relevant art. My qualifications are stated more fully in my *curriculum vitae*, which has been provided as Appendix A. Here, I provide a brief summary of my qualifications.

4. I am over the age of 18 and am competent to make this declaration. I have personal knowledge or have developed knowledge of the technologies in the ’590 patent based upon education, training, or experience, of the matters set forth herein.

5. I received a Ph.D. in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology (“MIT”) in 1998. Beforehand, I received a Master of Science degree in Electrical Engineering and Computer Science in 1991, a Bachelor of Science degree in Electrical Engineering and Computer Science in 1989, and a Bachelor of Science degree in Physics in 1990, all from MIT.

6. I am currently self-employed as an independent technical consultant.

7. After I finished my undergraduate education, I became a Research Assistant in the Telemedia Network Systems (“TNS”) group at the Laboratory for Computer Science. The TNS group built a high-speed gigabit network and created applications that ran over the network. Example video applications included ones for remote video capture, processing, storage, and display of video on computer terminals. In addition to working on the design of core network components, designing and building the high-speed links, and designing and programming the device drivers for the interface cards, I also set up the group’s web server.

8. I also helped to build the web pages that initiated the above-mentioned video sessions via a web interface. Vice President Al Gore visited our group in 1996 and received a demonstration of—and remotely drove—a radio-controlled toy car with a wireless video camera mounted on it that was built by our group. This toy car device received commands transmitted over a network from a

remote computer, and video data from the toy car was transmitted wirelessly then over a computer network back to the user controller. On occasion, we allowed users visiting our web site to drive the toy car from their remote computer while they watched the video on their computer. The video stream was encoded by TNS-designed hardware, streamed over the TNS-designed network, and displayed using TNS-designed software.

9. I defended and submitted my Ph.D. thesis, titled “Designing Networks for Tomorrow’s Traffic,” in January 1998. As part of my thesis research, I analyzed local area and wide area flows to show a more efficient method for routing packets in a network, based on traffic patterns at the time.

10. From 1997 to 1999, I was a Senior Scientist and Engineer at NBX Corporation, a start-up company that made business telephone systems for streaming packetized audio over data networks instead of using traditional telephone lines. Our system incorporated an auto-attendant, which was a basic interactive voice response (IVR) application to route calls to an extension or voice mailbox. For example, the auto-attendant could be programmed to provide a prompt such as “Press 1 for sales, 2 for support, 3 for directions, or dial an extension” and route the call accordingly based on the caller’s touch tone input. Our voicemail system also provided voice prompts and menu selections in which a caller or user may select various options in the voicemail system.

11. As part of my work at NBX, I designed the core audio reconstruction algorithms for the telephones, as well as the packet transmission algorithms. I also designed and validated the core packet transport protocol used by the phone system. The protocol was used for all signaling in the phone system, including for the setup of conference calls. The NBX system also featured a computer interface for initiating phone calls, which could also initiate conference calls. The NBX system also supported the Telephony Application Programming Interface (“TAPI”) that allowed other computer programs to integrate with our system telephony features. We obtained U.S. Patent No. 6,697,963, entitled “Telecommunication method for ensuring on-time delivery of packets containing time-sensitive data,” as part of this work. NBX was later acquired by 3Com Corporation and the phone system is used by numerous businesses and remains available online.

12. From 1999-2004, I was employed by Empirix or its predecessor company, Teradyne. Empirix was a leader in test tools for telecommunications protocols and systems, providing functional testing tools as well as load testing tools. One of Empirix’s core products was the Hammer, a telecommunications test platform that was used for functional and load testing. The Hammer was commonly used to test IVR systems, and Hammer also offered a testing service for IVRs. From my work with the testing service business, I received U.S. Patent 7,590,542, titled “Method of generating test scripts using a voice-capable markup

language”, which disclosed a method “for generating test scripts for testing an IVR from an IVR’s voice-capable markup language application.” (EX1052.) From 2000-2001, I conceived of and built a test platform for testing Voice-over-IP (VoIP) based on highly parallel network processors. The first application on this new test platform was a cloud emulator for simulating the effects of transmitting VoIP over a busy network. The platform was based on a multi-core high performance network processor chip.

13. In 2005, as part of my role at BBN Technologies, I helped create BBN’s Avoke call analytics business, which was a service for testing and monitoring the IVR systems within call centers. Avoke was used by companies and organizations such as Dell and the Center for Medicare and Medicaid Services (CMMS). Avoke analyzed millions of calls into the CMMS call center IVRs during the roll-out of the Affordable Care Act.

14. Also at BBN, I helped found PodZinger Inc., now known as RAMP Inc. PodZinger utilized BBN’s speech recognition algorithms to search through the spoken words in audio and video segments. While I was Vice President of Operations and Technology, PodZinger followed its initial prototype with a full streaming audio and video search solution.

15. I have been awarded several United States patents, and I have several patent publications including the following examples:

- U.S. Patent No. 7,975,296, “Automated security threat testing of web pages”;
- U.S. Patent No. 7,877,736, “Computer language interpretation and optimization for server testing”;
- U.S. Patent No. 7,801,910, “Method and apparatus for timed tagging of media content”;
- U.S. Patent No. 7,590,542, “Method of Generating Test Scripts Using a Voice-Capable Markup Language”;
- U.S. Patent No. 6,967,963, “Telecommunication method for ensuring on-time delivery of packets containing time-sensitive data”.

16. Additional details regarding my professional qualifications, experience, and publications are set forth in my curriculum vitae (“CV”), which is attached as Appendix A.

III. MATERIALS CONSIDERED

17. In preparing this declaration, I have reviewed, among other things, the ’590 patent and file history. I have also considered each of the documents cited in this Declaration and the documents specifically identified below and in the Exhibit List. In formulating my opinions, I have further relied upon my extensive experience in the relevant fields.

IV. OVERVIEW OF THE '590 PATENT

A. Filing Date and Priority Dates

18. The '590 patent was filed on May 30, 2018, and issued on November 30, 2021. The '590 patent claims earliest priority to a US provisional application that was filed on January 9, 2012, which I am informed that the Petitioner treats as the earliest effective filing date only for purposes of this proceeding.

B. Specification

19. The '590 patent is directed to an “Alternating-Current (AC) powered appliance associated with food storage, handling, or preparation for use with a wireless network.” (EX1001, Claim 1.) During prosecution, Patent Owner identified **FIG. 5e** of the '590 patent as illustrating the claimed system. (EX1003, 190-193, 420, 593.)

20. FIG. 5e is reproduced below.¹ FIG. 5e shows, and the Board found during prosecution, that the claimed **appliance** (shown in the red dashed-line box) can comprise both “appliance 58a” and a separate “**single enclosure 50e**.” (EX1003, 193, 420; EX1001, Claim 1.) The claimed appliance also has “an **AC Connector** (such as **item 59f**, **59g**, or **59h**, in Figure 5e) for connecting the appliance [58a] to an AC power source.” (EX1003, 420; EX1001, Claim 1.)

¹ All emphasis and annotations are added unless otherwise stated.

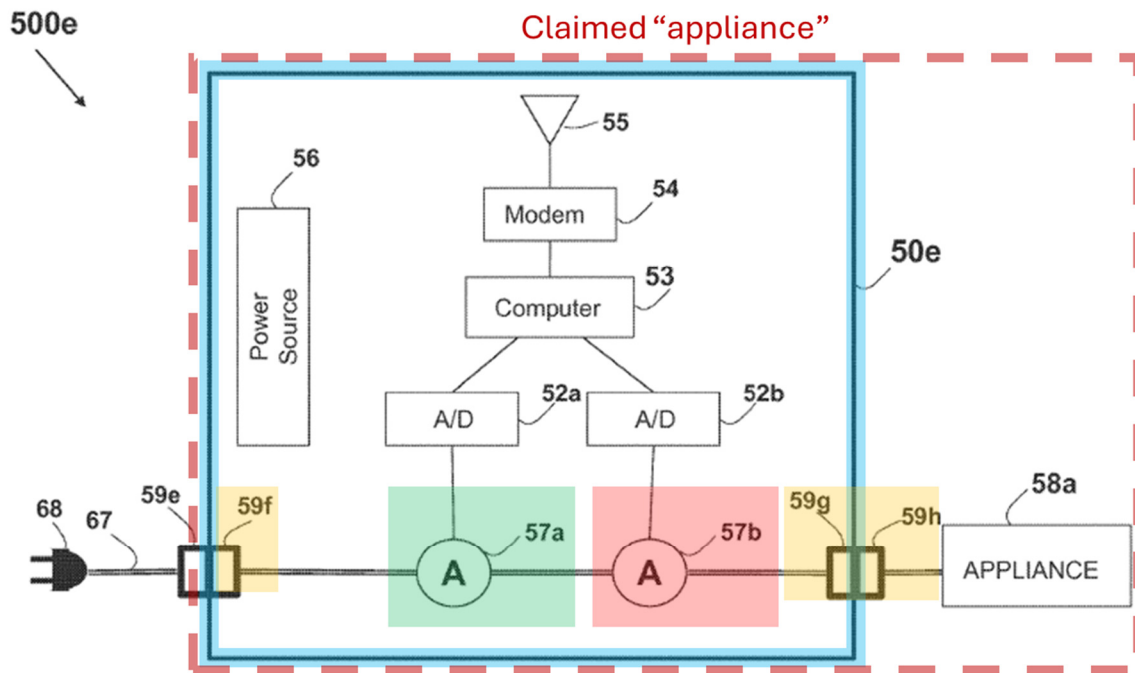


FIG. 5e

21. The *single enclosure 50e* houses several claimed elements. The “*single enclosure* (such as *item 50e* in Figure 5e) hous[es] [a] *current sensor [57a]*², [an] antenna, and a wireless transceiver.” (EX1003, 420.) The “*current sensor* (such as *item 57a* or 57b in Figure 5e) [is] coupled to the *AC connector* for measuring an AC current consumed by the appliance.” (EX1003, 420.) The

² I note that the '590 patent indicates that either one of current sensor 57a or current sensor 57b can be the current sensor or the first sensor. For illustrative purposes, I am annotating current sensor 57a as the current sensor and current sensor 57b as the first sensor.

“antenna (such as item 55 in Figure 5e) [is] for communication over the wireless network.” (EX1003, 420.) The “wireless transceiver (such as item 54 in Figure 5e) [is] coupled to the antenna for transmitting digital data to, and for receiving digital data from the wireless network.” (EX1003, 420.) The *single enclosure 50e* also houses a generic “*first sensor* [*e.g.*, *57b* in FIG. 5e] having an output that responds to a physical phenomenon,” which was added to claim 1 to obtain allowance. (EX1001, Claim 1; EX1003, 166-179.) A physical phenomenon is broadly defined by the patent as encompassing “temperature, humidity, pressure, audio, vibration, light, motion, sound, proximity, flow rate, electrical voltage, and electrical current.” (EX1001, 16:44-50.) Both the current sensor and the first sensor are coupled to the wireless transceiver for transmitting digital data. (EX1001, Claim 1.)

22. By the specification’s own admission, each of these elements is an off-the-shelf part. The “*current sensor*” may be a conventional ammeter, current clamp, transformer, or Hall-effect probe. (EX1001, 18:26-19:12, 68:50-69:21.) The “*first sensor*” covers nearly every type of known sensor (*e.g.*, smoke sensors, blood pressure sensors, voltmeters, capacitance meters, magnetic sensors, strain gauge, angular sensors, etc.) without any discussion of a particular configuration or use. (EX1001, 16:44-22:2, 62:66-81:60.) The wireless transceivers and antennas rely on established standards such as Bluetooth, ZigBee, Wi-Fi, WiMAX, or

cellular, where each is based on existing IEEE or GSM specifications. (EX1001, 8:25-32, 45:49-67, 47:34-51, 152:18-38.) In operation, “[t]he appliance is controlled or activated in response to digital data received from the wireless network (Figure 17).” ((EX1003, 420-421.)

C. Claims

23. I was asked to evaluate whether claims 1-36 and 38-63 of the ’590 patent are patentable.

24. There is one independent claim. Claim 1 is directed to an Alternating-Current (AC) powered appliance.” The appliance comprises an AC connector for connecting the appliance to an AC power source and a current sensor coupled to the AC connector for measuring an AC current consumed by the appliance. The appliance further comprises a first sensor having an output that responds to a physical phenomenon. The appliance also includes an antenna for communication over the wireless network and a wireless transceiver coupled to the antenna for transmitting digital data to, and for receiving digital data from, the wireless network. The current sensor, the first sensor, the antenna, and the wireless transceiver are housed in a single enclosure. The first sensor and the current sensor are both coupled to the wireless transceiver for transmitting digital data to the wireless network in response to the physical phenomenon and the measured AC

current to the wireless network. The appliance is controlled or activated in response to digital data received from the wireless network.

25. There are 62 dependent claims. Claim 2 requires the appliance to have a primary function of heating food. Claim 3 depends from claim 2, and specifies that the appliance comprises a microwave oven, an electric mixer, a stove, an oven, or an induction cooker.

26. Claim 4 requires the appliance to have a primary function of cooling food. Claim 5 depends from claim 4, and requires the appliance to comprise a refrigerator, a freezer, or an iced-tea maker.

27. Claim 6 requires the appliance to comprise a dishwasher, a food blender, a beverage maker, or a coffeemaker.

28. Claim 7 requires the appliance further comprise, in the single enclosure, an electrically actuated switch connected to a switch electric power to at least part of the appliance, wherein the electrically actuated switch is coupled to the wireless transceiver for being activated in response to digital data received from the wireless network. Claim 8 depends from claim 7, and requires the electrically actuated switch to be a 'normally open' type, 'normally closed' type, or a changeover switch, wherein the electrically actuated switch is 'make-before-break' or 'break-before-make' type, or wherein the electrically actuated switch have two or more poles or two or more throws, and contacts of the electrically

actuated switch are arranged as a Single-Pole-Double-Throw (SPDT), Double-Pole-Double-Throw (DPDT), Double-Pole-Single-Throw (DPST), or Single-Pole-Changeover (SPCO). Claim 9 also depends from claim 7, and requires the electrically actuated switch to be a latching or a non-latching type relay. Claim 10 depends from claim 9, and requires the relay to be a solenoid-based electromagnetic relay that is a reed relay, wherein the relay is solid-state or semiconductor based, or wherein the relay is a Solid State Relay (SSR). Claim 11 also depends from claim 7, and requires the electrically actuated switch to be based on an electrical circuit that comprises an open collector transistor, an open drain transistor, a thyristor, a TRIAC, or an opto-isolator.

29. Claim 12 requires the current sensor to comprise an ampermeter, galvanometer, or a hot-wire ampermeter. Claim 13 requires the current sensor to comprise a current clamp, a current probe, a current transformer, or uses a 'Hall effect'. Claim 14 requires the current sensor to be a non-contact or a non-conductive current meter.

30. Claim 15 requires the appliance to further comprise, in the single enclosure, a wattmeter connected to the AC connector for measuring the magnitude of the active AC power or an electrical energy consumed by the appliance. Claim 16 depends from claim 15, and requires the wattmeter to comprise a single or multi-phase AC power or energy meter. Claim 17 also

depends from claim 15, and requires the wattmeter to comprise a bolometer, or wherein the wattmeter accumulates or averages readings. Claim 18 also depends from claim 15, and requires the wattmeter to comprise the current sensor, or the wattmeter to be based on multiplying a measured voltage and the current measured by the current sensor. Claim 19 also depends from claim 15, and requires the wattmeter or the current sensor to be induction based.

31. Claim 20 requires the wireless network to be a Wireless Personal Area Network (WPAN), the antenna to be a WPAN antenna, and the wireless transceiver to be a WPAN modem. Claim 21 depends from claim 20, and requires the WPAN to be according to, based on, or compatible with, Bluetooth™ or Institute of Electrical and Electronics Engineers (IEEE) 802.15.1-2005 standards. Claim 22 also depends from claim 20, and requires the WPAN to be according to, based on, or compatible with, Zigbee™, IEEE 802.15.4-2003, or Z-Wave™ standards.

32. Claim 23 requires the wireless network to be a Wireless Local Area Network (WLAN), the antenna to be a WLAN antenna, and the wireless transceiver to be a WLAN modem. Claim 24 depends from claim 23, and requires the WLAN to be according to, based on, or compatible with, IEEE 802.11-2012, IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, IEEE 802.11n, or IEEE 802.11ac.

33. Claim 25 requires the wireless network to be a wireless broadband network. Claim 26 requires the wireless network to use a licensed or unlicensed radio frequency band. Claim 27 depends from claim 26 and requires the unlicensed radio frequency band to be an Industrial, Scientific, and Medical (ISM) radio band.

34. Claim 28 requires the wireless network to be a satellite network, the antenna to be a satellite antenna, and the wireless transceiver to be a satellite modem.

35. Claim 29 requires the wireless network to be a WiMAX network, wherein the antenna is a WiMAX antenna and the wireless transceiver is a WiMAX modem, and wherein the WiMAX network is according to, or based on, or compatible with, IEEE 802.16-2009.

36. Claim 30 requires the wireless network to be a cellular telephone network, the antenna to be a cellular antenna, and the wireless transceiver to be a cellular modem. Claim 31 depends from claim 30, and requires the cellular telephone network to be a Third Generation (3G) network that uses Universal Mobile Telecommunications System (UMTS), Wideband Code Division Multiple Access (W-CDMA) UMTS, High Speed Packet Access (HSPA), UMTS Time-Division Duplexing (TDD), CDMA2000 1×RTT, Evolution-Data Optimized (EV-DO), or Global System for Mobile communications (GSM), Enhanced Data rates

for GSM Evolution (EDGE) EDGE-Evolution, or requires the cellular telephone network to be a Fourth Generation (4G) network that uses Evolved High Speed Packet Access (HSPA+), Mobile Worldwide Interoperability for Microwave Access (WiMAX), Long-Term Evolution (LTE), LTE-Advanced, Mobile Broadband Wireless Access (MBWA), or to be based on IEEE 802.20-2008.”

37. Claim 32 requires the appliance to further comprise an electrically actuated switch connected to switch electric power to at least part of the appliance, the switch is coupled to the first sensor for being activated in response to the physical phenomenon.

38. Claim 33 requires the first sensor to be a piezoelectric sensor that includes a single crystal material or a piezoelectric ceramics and uses a transverse, longitudinal, or shear effect mode of the piezoelectric effect.

39. Claim 34 requires the appliance to further comprise multiple sensors arranged as a directional sensor array operative to estimate a number, magnitude, frequency, Direction-Of-Arrival (DOA), distance, or speed of the physical phenomenon impinging the sensor array.

40. Claim 35 requires the first sensor to be a thermoelectric sensor that responds to a temperature or to a temperature gradient of an object using a conduction, convection, or radiation, and wherein the thermoelectric sensor consists of, or comprises, a Positive Temperature Coefficient (PTC) thermistor, a

Negative Temperature Coefficient (NTC) thermistor, a thermocouple, a quartz crystal, or a Resistance Temperature Detector (RTD).

41. Claim 36 requires the first sensor to consist of, or comprise, a nanosensor, a crystal, or a semiconductor. Claim 38 requires the first sensor to consist of, or comprise, an atmospheric or an environmental sensor.” Claim 39 requires the first sensor to consist of, or comprise, a bulk or surface acoustic sensor. Claim 40 requires the first sensor to consist of, or comprise, a radiation sensor that responds to radioactivity, nuclear radiation, alpha particles, beta particles, or gamma rays, and is based on a gas ionization. Claim 41 requires the first sensor to consist of, or comprise, a photoelectric sensor that responds to a visible or an invisible light, and wherein the invisible light is infrared, ultraviolet, X-rays, or gamma rays.

42. Claim 42 requires the photoelectric sensor to be based on the photoelectric or photovoltaic effect, and consist of, or comprise, a semiconductor component that consists of, or comprises, a photodiode, a phototransistor, or a solar cell. Claim 43 depends from claim 42 and requires the photoelectric sensor to be based on Charge-Coupled Appliance (CCD) or a Complementary Metal-Oxide Semiconductor (CMOS) element.

43. Claim 44 requires the first sensor consist of, or comprise, a photosensitive image sensor array comprising multiple photoelectric sensors, for

capturing an image and producing electronic image information representing the image, and the appliance to further comprise one or more optical lens for focusing the received light and to guide the image, and wherein the image sensor to be disposed approximately at an image focal point plane of the one or more optical lens for properly capturing the image. Claim 45 depends from claim 44, and requires the appliance to further comprise an image processor coupled to the image sensor for providing a digital data video signal according to a digital video format, the digital video signal carrying the digital data video based on the captured images, and wherein the digital video format is based on one out of: TIFF (Tagged Image File Format), RAW format, AVI, DV, MOV, WMV, MP4, DCF (Design Rule for Camera Format), ITU-T H.261, ITU-T H.263, ITU-T H.264, ITU-T CCIR 601, ASF, Exif (Exchangeable Image File Format), and DPOF (Digital Print Order Format) standards.

44. Claim 46 requires the first sensor consist of, or comprise, an electrochemical sensor that responds to an object chemical structure, properties, composition, or reactions. Claim 47 depends from claim 46, and requires that the electrochemical sensor consist of, or comprise, a pH meter or a gas sensor responding to a presence of radon, hydrogen, oxygen, or Carbon-Monoxide (CO), or requires that the electrochemical sensor is based on an optical detection or on an

ionization and is a smoke, a flame, or a fire detector, or is responsive to a combustible, flammable, or toxic gas.

45. Claim 48 requires that the first sensor consists of, or comprises, an electroacoustic sensor that responds to an audible or inaudible sound. Claim 49 depends from claim 48, and requires that the electroacoustic sensor is an omnidirectional, unidirectional, or bidirectional microphone that is based on the sensing an incident sound-based motion of a diaphragm or a ribbon, and the microphone consists of, or comprises, a condenser, an electret, a dynamic, a ribbon, a carbon, or a piezoelectric microphone.

46. Claim 50 requires that the appliance further comprises, in the single enclosure, a light source that emits a visible or non-visible light for illumination or indication, the non-visible light is infrared, ultraviolet, X-rays, or gamma rays. The light source is coupled to the AC connector for being powered from the AC power, and the light source is coupled to the wireless transceiver for illumination or indication in response to digital data received from the wireless network. Claim 51 depends from claim 50 and requires that the light source be coupled to the current sensor for illumination or indication in response to the measured AC current. Claim 52 also depends from claim 50, and requires that the light source consists of, or comprises, a lamp, an incandescent lamp, a gas discharge lamp, a

fluorescent lamp, a Solid-State Lighting (SSL), a Light Emitting Diode (LED), an Organic LED (OLED), a polymer LED (PLED), or a laser diode.

47. Claim 53 requires that the appliance further comprises, in the single enclosure, an actuator for affecting the physical phenomenon, wherein the actuator is coupled to the wireless transceiver for being activated or controlled in response to digital data received from the wireless network. Claim 54 depends from claim 53, and requires that the actuator consists of, or comprises, a motion actuator that causes a linear or rotary motion, and the appliance further comprising a conversion mechanism for respectfully converting to rotary or linear motion based on a screw, a wheel and axle, or a cam. Claim 55 also depends from claim 53, and requires that the actuator consists of, or comprises, a sounder for converting an electrical energy to omnidirectional, unidirectional, or bidirectional pattern emitted, audible or inaudible, sound waves. Claim 56 also depends from claim 53, and requires that the actuator consists of, or comprises, an electromagnetic coil or an electromagnet operative for generating a magnetic or electric field. Claim 57 also depends from claim 53, and requires that the actuator consists of, or comprises, an electrical signal generator. Claim 58 also depends from claim 53, and requires that the actuator consists of, or comprises, a chemical or an electrochemical actuator, and is operative for producing, changing, or affecting a matter structure, properties, composition, process, or reactions. Claim 59 also depends from claim 53, and

requires that the actuator consists of, or comprises, a thermoelectric actuator and is a heater or a cooler, operative for affecting the temperature of a solid, a liquid, or a gas object, and is coupled to the object by conduction, convection, force convention, thermal radiation, or by the transfer of energy by phase changes.

48. Claim 60 requires that the appliance be further addressable in the wireless network using distinct locally administered addresses or universally administered digital addresses stored in a volatile or non-volatile memory in the single enclosure, which uniquely identifies the appliance in the wireless network or in the Internet. Claim 61 depends from claim 60, and requires the digital address is a Media Access Control (MAC) layer address that is MAC-48, Extended Unique Identifier (EUI) EUI-48, or EUI-64 address type. Claim 62 also depends from claim 60 and requires that the digital address be a layer 3 address and is static or dynamic Internet Protocol (IP) address that is IPv4 or IPv6 type address. Claim 63 also depends from claim 60, and requires that the digital address be autonomously assigned, or wherein the digital address is assigned by another appliance using Dynamic Host Configuration Protocol (DHCP).

D. Prosecution History

49. The application that matured into the '590 patent was filed on May 30, 2018. (EX1003, 1389.) The application underwent lengthy examination, with a total of five Office Actions and an *ex parte* appeal before the Board. The

Board's decision on appeal affirmed most rejections and reversed only a few dependent claims. (EX1003, 251.)

50. Regarding the "single enclosure" limitation, the Board held that the claimed appliance does not need to be in the recited "single enclosure." (EX1003, 189-193.) During prosecution, the Applicant unsuccessfully argued that claim 1 as directed to "a single appliance in a single enclosure" in order to overcome a reference disclosing an appliance with a separate plug enclosure. (EX1003, 422-424.) The Applicant contended that prior-art reference Sharood disclosed two separate devices, an appliance 130 and a retrofit plug 125, and therefore failed to meet the "single enclosure" requirement. (EX1003, 422-424.)

51. The Board rejected that the claimed appliance must be in the single enclosure. (EX1003, 189-193.) The Board held:

We do not find these limitations in claim 1, where the appliance is recited, quite broadly, as merely comprising the single enclosure, but not being enclosed within the single enclosure or enclosing the single enclosure. To the contrary, although open-ended, *claim 1 requires only that the single enclosure houses the current sensor, the antenna, and the wireless transceiver*. Moreover, Appellant refers to the claimed appliance as corresponding to item 50e or 58a in Figure 5e (see Appeal Br. 3), thus

exemplifying the arrangement as claimed featuring the appliance 58a of Figure 5e as separate from the single enclosure 50e. (EX1003, 193.)

52. Rejecting the Applicant's narrow interpretation, the Board found Sharood's configuration (appliance 130 connected to retrofit plug 125) discloses the claimed appliance and sustained the Examiner's anticipation rejection for claim 1, among others. (EX1003, 193-194.)

53. The Board reversed a few rejections of dependent claims, including a § 102 rejection of dependent claim 32 directed to "[t]he appliance according to claim 1, further comprising in the single enclosure a first sensor having an output that responds to a physical phenomenon, the first sensor is coupled to the wireless transceiver for transmitting digital data in response to the measured physical phenomenon to the wireless network." (EX1003, 197, 479.) The Board found the § 102 rejection to be lacking, merely because the Examiner relied on a different embodiment in the prior art than the embodiment used for claim 1 and was thus insufficient for anticipation. (EX1003, 197.)

54. Following the PTAB decision, the Applicant did not dispute the Board's ruling the enclosure can be "separate from" (*i.e.*, external to) the appliance. (EX1003, 166-179.) Nor did the Applicant amend the claim to explicitly require the claimed appliance to be in the single enclosure. (EX1003, 166-179.) Instead, the Applicant filed an amendment incorporating claim 32,

erroneously alleging that “the content of the PTAB *allowed* claim 32 is incorporated into claim 1.” (EX1003, 178.)

55. The Examiner nevertheless issued a Notice of Allowability on October 19, 2021, citing the PTAB decision in the “Reasons for Allowance.” (EX1003, 34.) The Examiner’s “Reasons for Allowance” stated, “[a]s per the Patent Trial and Appeal Board decision rendered on 07/22/2021 for Appeal 2020-002710 and MPEP § 1214.05, Claims 1-64 are allowable.” (EX1003, 34.)

56. But the Board never “allowed” claim 32. (EX1003, 197.) Rather, it held the Examiner erroneously relied on different embodiments for anticipation. The added claim 32 merely recited a generic “first sensor having an output that responds to a physical phenomenon” and that is “coupled to the wireless transceiver for transmitting digital data . . .” (EX1003, 479.) The Examiner failed to consider obviousness, and this trivial addition should not have been a basis for allowance.

V. RELEVANT LEGAL STANDARDS AND DEFINITIONS

A. Obviousness

57. I have been informed that a claim is unpatentable if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time the claimed subject matter was made to POSITA to which the subject matter pertains. I have also been

informed that a patent claim may be obvious to a POSITA in view of the prior art teachings of a single reference or a combination of references.

58. To assess obviousness, I have been informed that I am to consider the scope and content of the prior art, the differences between the prior art and the claim, the level of ordinary skill in the art, and any secondary considerations to the extent that they exist.

59. I have also been informed that there are principles that may be used as further guidance in obviousness analysis (especially when considering combinations of references), which include considering whether:

- the claimed subject matter is simply a combination of prior art elements according to known methods to yield predictable results;
- the claimed subject matter is a simple substitution of one known element for another to obtain predictable results;
- the claimed subject matter uses known techniques to improve similar devices or methods in the same way;
- the claimed subject matter applies a known technique to a known device or method that is ready for improvement to yield predictable results;
- the claimed subject matter would have been “obvious to try” choosing from a finite number of identified, predictable solutions, with a

reasonable expectation of success;

- there is known work in one field of endeavor that may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to a POSITA;
- there existed at the time of conception and reduction to practice a known problem for which there was an obvious solution encompassed by the patent's claims; and
- there is some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed subject matter.

60. I have been informed that there are secondary considerations that may tend to show that a claimed invention would not have been obvious to a POSITA. These include, for example, commercial success, long-felt but unsolved needs, failure of others, and unexpected results. I have been further informed that there must be a relationship, or nexus, between any secondary considerations and the novelty of the claimed invention.

A. Prior Art

61. I am informed and understand that prior art includes patents and printed publications that existed before the effective filing date of the claimed

invention. The effective filing date is the earliest claimed priority date or the earliest filing date of the application that describes the subject matter. A patent or published patent application is prior art if it was filed before the earliest filing date of the claimed invention, absent a few exceptions. I am informed that a patent or published patent application is entitled to have its effective filing date as the filing date of its provisional application if the disclosure of the provisional application provides support for the claim(s) of the patent or published patent application.

VI. LEVEL OF ORDINARY SKILL IN THE ART FOR THE '710 PATENT

62. I am informed and understand that various factors can be considered in determining a person of ordinary skill in the art (POSITA). I am informed and understand that those factors include: (1) the education level of the inventors; (2) the type of problems encountered in the art; (3) prior art solutions to those problems; (4) the rapidity with which innovations are made; (5) sophistication of the technology; and (6) education level of active workers in the field.

63. A POSITA in the field of the '590 patent would have a bachelor's degree in electrical engineering, computer engineering, or equivalent, and two years of experience working on remote device control and/or networked devices. An advanced graduate degree may make up for the work experience indicated above.

64. I agree with this level of ordinary skill for the '590 patent. Based on my experience, as described above and in Appendix A, I meet the definition of the qualifications of a POSITA, now and as of the alleged priority date. For purposes of this declaration, in general, and unless otherwise noted, my statements and opinions, such as those regarding my own experience, what a POSITA would have understood or known generally (and specifically related to the references I consulted herein), and how a POSITA would have understood and used the terminology found in the '590 patent, reflect the knowledge that existed in the relevant field at the time the '590 patent priority application was filed, and with the state of the art at that time.

VII. CLAIM CONSTRUCTION

65. I have been informed that claim construction requires consideration of the words of the claims themselves, the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art. I have also been informed that the specification is usually definitive, as it was the single best guide to the meaning of a disputed term. I have been informed that claim terms are presumed to carry their ordinary and customary meaning as understood by a POSITA at the time of the purported invention. I have been informed that, in the context of this proceeding, which requires the Board to construe the terms only to the extent necessary to

resolve the issue at hand—invalidity of the claims under 35 U.S.C. §103, Petitioner believes the Board need not construe any of the claims because, as set forth in both the Declaration and Petition, the claims are invalid under 35 U.S.C. §103 under any reasonable interpretation, and thus, no claim construction is necessary to resolve any issue before the Board.

VIII. PRIOR ART

66. I understand that each of the references discussed herein qualifies as prior art against the '590 patent:

67. U.S. Pat. Publication No. 2010/0238003 (“Chan,” EX1004) was filed on August 30, 2009, and published September 23, 2010.

68. U.S. Pat. No. 8,461,861 (“Botts,” EX1006) was filed on November 11, 2008, and issued June 11, 2013.

69. “Practical Electronics for Inventors” (“Scherz,” EX1007) was written by Paul Scherz and published in its second edition by McGraw-Hill in 2007. (EX1030.)

70. “Handbook of Sensors and Actuators: Measuring Current, Voltage and Power” (“Middelhoek,” EX1008) was written by S. Middelhoek et al. and published by Elsevier in 1999. (EX1031.)

71. “Wireless Communications” (“Goldsmith,” EX1009) was written by Andrea Goldsmith, and published by Cambridge University Press in 2005.

(EX1009.)

72. “Springer Handbook of Acoustics” (“Rossing,” EX1010) was edited by Thomas D. Rossing et al., and published by Springer Science+Business Media, LLC in 2007. (EX1032.)

73. “Springer Handbook of Speech Processing” (“Benesty,” EX1011) was written by Jacob Benesty et al., and published by Springer-Verlag Berlin Heidelberg in 2008. (EX1033.)

74. “Handbook of Modern Sensors” (“Fraden,” EX1012) was written by Jacob Fraden and published by Springer Science+Business Media, LLC in 2010. (EX1034.)

75. “Wireless Home Networking Simplified” (“Doherty,” EX1013) was written by Jim Doherty et al., and published by Cisco Press in 2007. (EX1035.)

76. “Forced Air Cooling of CPUs with Heat Sinks: A Numerical Study” (“Ozturk,” EX1014) was written by Emre Ozturk et al. and published in *IEEE Transactions on Components and Packaging Technologies*, Vol. 31, No. 3, in September 2008. (EX1036.)

77. Korean Pat. Pub. No. KR20100083686A (“Seo,” EX1005) was filed on August 28, 2009, and published July 22, 2010.

78. “Thin Film Transistor Technologies (TFTT VII): Proceedings of the International Symposium” (“Kuo,” EX1015) was edited by Yue Kuo and published by The Electrochemical Society in 2005. (EX1037.)

79. U.S. Pat. Publication No. 2010/0149163 (“Betts-LaCroix,” EX1050) was filed on August 10, 2009, and published June 17, 2010.

IX. ANALYSIS AND OPINIONS

A. Ground 1: Chan Renders Obvious Claims 1-7, 13, 15, 16, 19-27, 29, 30, 32, 38, 41, 44-46, 53

1. Summary of Chan

80. Chan was filed on August 30, 2009, and published September 23, 2010, before the earliest provisional application filing date of the ’590 patent, and thus qualifies as prior art under §102(b). (EX1004, 1.) The Examiner never found, and Applicant never cited, Chan during prosecution.

81. Chan is generally related to “techniques for monitoring and controlling various appliances or client devices.” (EX1004, [0038].) FIG. 1 of Chan illustrates a system 100 for an energy monitoring and control network that includes familiar household appliances such as refrigerators, washers and dryers, ranges, stoves, and microwaves. (EX1004, [0047].) Each *appliance* includes an *appliance module 111*, which serves as the interface between the appliance and the broader energy monitoring network. (EX1004, [0046]-[0047].) For example, the *appliance module 111* “may be adapted to *measure, store and or control energy*

usage of connected appliances or devices, bridge Zigbee wireless sensors and devices to the network, or *receive and transmit information across network infrastructure*.” (EX1004, [0047].) Together, the appliances, appliance modules and gateway form Chan’s “system 100 for an energy monitoring and control network.” (EX1004, [0045].)

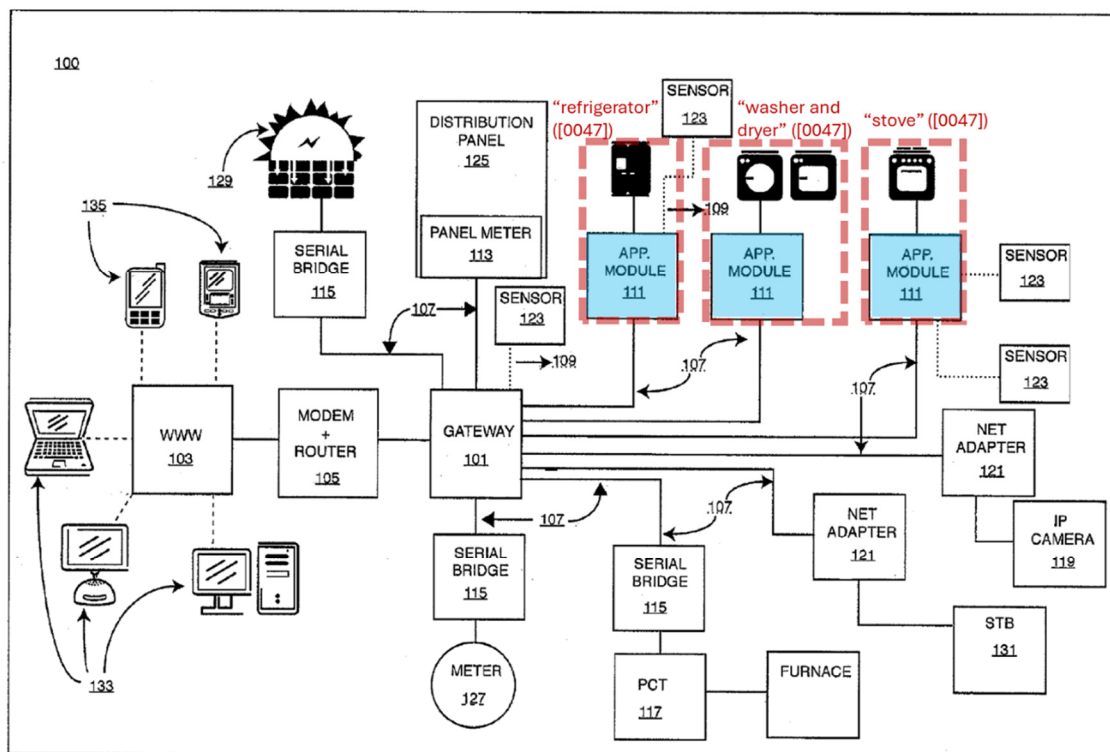


FIG. 1

82. Each *appliance module* is a *device (i.e., a single enclosure)*, housing multiple components for energy monitoring, wireless communication, and appliance control. (EX1004, [0070]-[0071].) In operation, the *appliance module* “sit[s] between a client device [*e.g.*, stove, refrigerator, etc.] and a standard wall

electrical outlet,” plugging directly into the outlet and providing a socket for the appliance itself. (EX1004, [0071].) This configuration allows the appliance module to both deliver AC power to the appliance and simultaneously measure the current being drawn. (EX1004, [0071].) Chan explains that the module “may be embodied as a device which may be plugged into an electrical outlet and ... simultaneously provide an outlet to a certain client device,” thereby serving as an intermediary power and control unit. (EX1004, [0071].)

83. As shown in FIG. 4, an *appliance module 400* provides “a *standard AC socket 427*” for plugging in the appliance. (EX1004, [0070].) “By plugging the client device [*e.g.*, stove, fridge, etc.] into the *outlet* of *appliance module 400*, the client device is able to obtain electrical power.” (EX1004, [0071].)

84. The *appliance module 400* has a *current sensor* for measuring an AC current consumed by the connected appliance. Specifically, “*current transformer[] (CT) 425a* ... [is] connected to a *standard AC socket 427*” and the “*CT 425a measures current* on the live wire 429 [of AC wiring].” (EX1004, [0070].) Accordingly, “the *appliance module* is able to take measurements of energy usage.” (EX1004, [0071].)

86. Chan describes other *first sensors* integrated into the appliance module, including a “*temperature/fog/brightness/infrared sensor 1107*, a *switch/relay/alarm sensor 1109*,” “a *thermal sensor*,” “a *humidity sensor*,” “a *security sensor*,” “a *motion sensor*,” “a *light sensor*,” “one or more *pressure sensors*,” “one or more *microphones*,” “one or more *vibration sensors*,” “a *gyro or an accelerometer*,” “one or more *smoke sensors*,” “*biological sensors*,” or “one or more combinations of sensor devices.” (EX1004, [0070], [0109], Claims 3-16.)

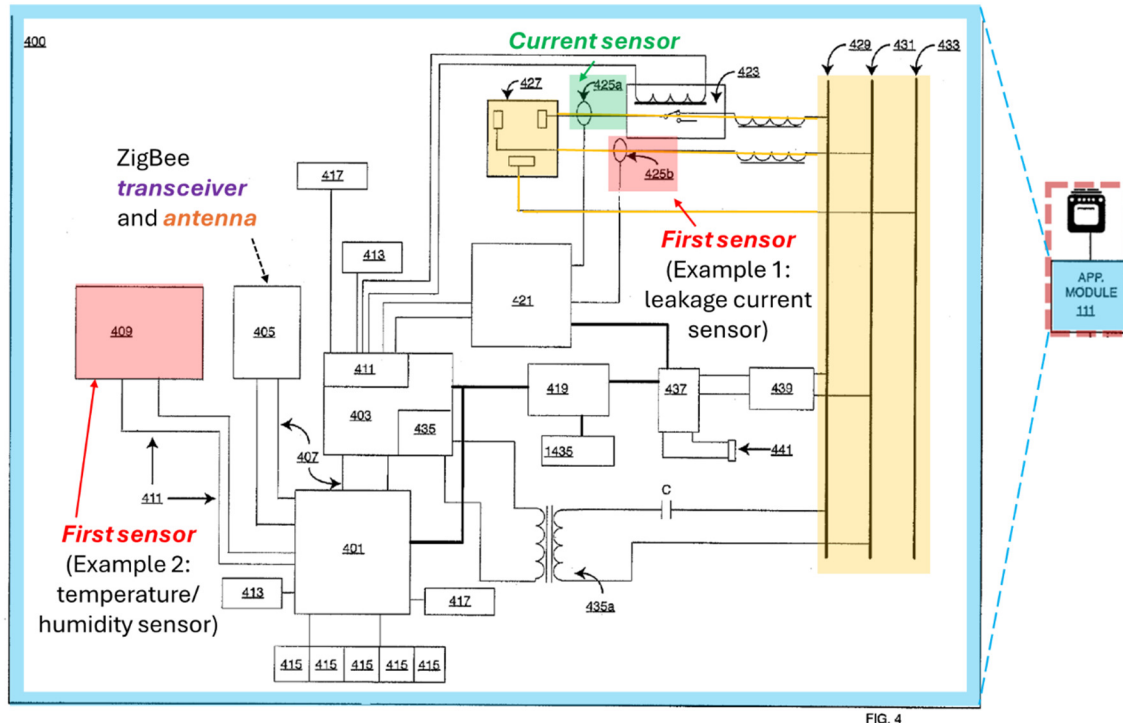
87. In operation, the *appliance module* wirelessly communicates with a gateway and controls the appliance accordingly. The gateway is a “master control station” that “creates the networking infrastructure needed for connecting a variety of appliances, devices, controls, and sensors to the World Wide Web.” (EX1004, [0008], [0053].) For example, “a low-bandwidth signal may carry command or control information from gateway 300 [*i.e.*, gateway 101 in FIG. 1] to *appliance module 111* and turn the connected appliance on or off.” (EX1004, [0057].)

88. Chan’s network infrastructure is provided by the *appliance module* and the gateway and forms a wireless network. For example, the *appliance module* “may send and receive powerline signals to gateway 300” or “[t]he powerline data signal sent between *appliance module 400* and gateway 300 may be further transmitted by *appliance module 400* as a wireless RF signal.” (EX1004, [0073], [0070].) Chan notes that “other wireless technologies, Wi-Fi,

ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media” may also be used. (EX1004, [0073].) By “bridging various wireless network media to powerline or other premises wiring networking technology, *appliance module 400* functions to provide a network backbone across premises wiring and allows wireless connectivity to such network backbone.” (EX1004, [0074].) For example, “[a]*appliance module 400* enhances the coverage and range of ZigBee or wireless network infrastructure by providing a bridge to the premises wiring network backbone.” (EX1004, [0074].) Using *appliance module 400*, “[p]reviously un-connected *client devices* [i.e., *appliances*] may be coupled to the network via *appliance module 400*.” (EX1004, [0074].) In this manner, *appliances* are “couple[ed] to *appliance module 400* for *command or control* by gateway 300.” (EX1004, [0074].)

89. A comparison between Chan’s *appliance module* and the ’590 patent’s FIG. 5e is shown below, illustrating their similarities. Both FIG. 5e of the patent and FIG. 4 of Chan depict a “*single enclosure* housing the *current sensor*, the *first sensor*, the *antenna*, and the *wireless transceiver*.” Both enclosures include “an *AC connector* for connecting the appliance to an AC power source.” Further, both enclosures show “the *first sensor* is coupled to the *wireless transceiver* for transmitting digital data in response to the physical phenomenon to the wireless network” and “the *current sensor* is further coupled to the *wireless*

transceiver for transmitting digital data in response to the measured AC current to the wireless network” as recited in claim 1 of the ’590 patent.



(EX1004, FIG. 4 (a portion of FIG. 1 is added on the right side, showing the relationship between the appliance module and an appliance).)

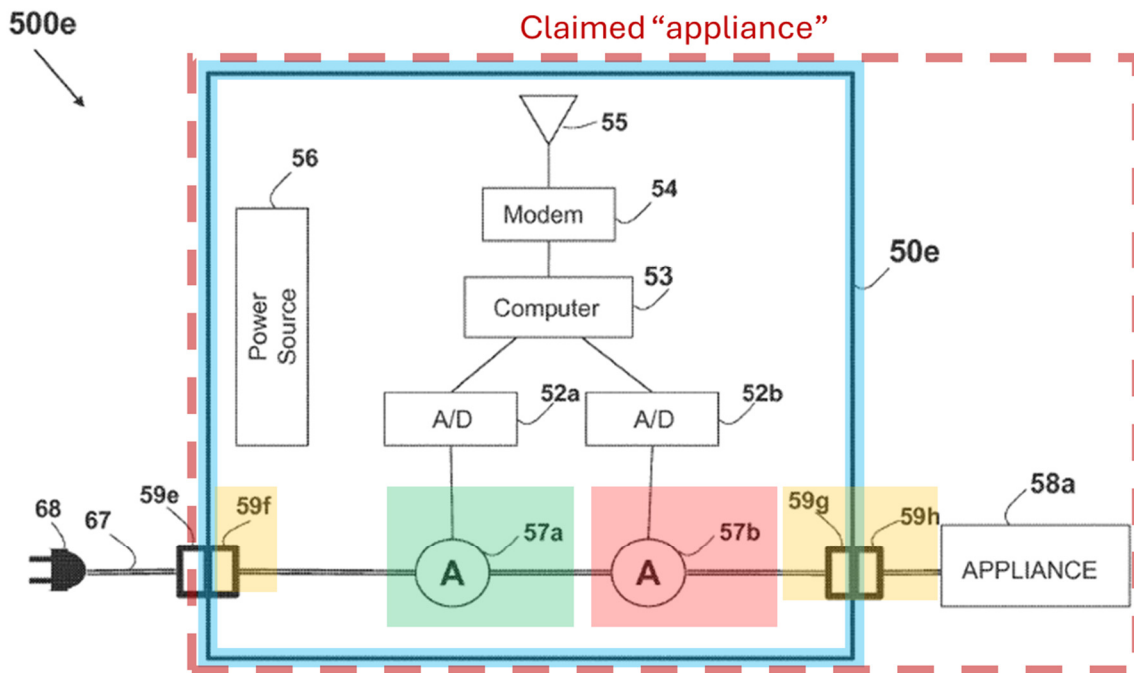


FIG. 5e

(EX1001, FIG. 5e.)

90. Chan is analogous to the field of the '590 patent. Both enhance performance of appliances via energy monitoring and wireless communication.

(EX1004, [0041]; EX1001, 62:34-63:18, 82:2-54, 83:39-85:29.)

2. Claim 1

a. 1[PR1]: “An Alternating-Current (AC) powered appliance”³

³ I show how each claim preamble is satisfied, but do not concede that any preamble is limiting for any ground in the proceeding.

91. Chan discloses an *alternating-current powered appliance*. For example, FIG. 1 illustrates a system that includes “an energy monitor unit for each *appliance load that plugs into a standard AC wall outlet and monitors power consumption.*” (EX1004, [0008].) Chan discloses appliances including: “*refrigerator,*” “*stove,*” “*microwave,*” such as those shown in FIG. 1. (EX1004, [0070]-[0071].)

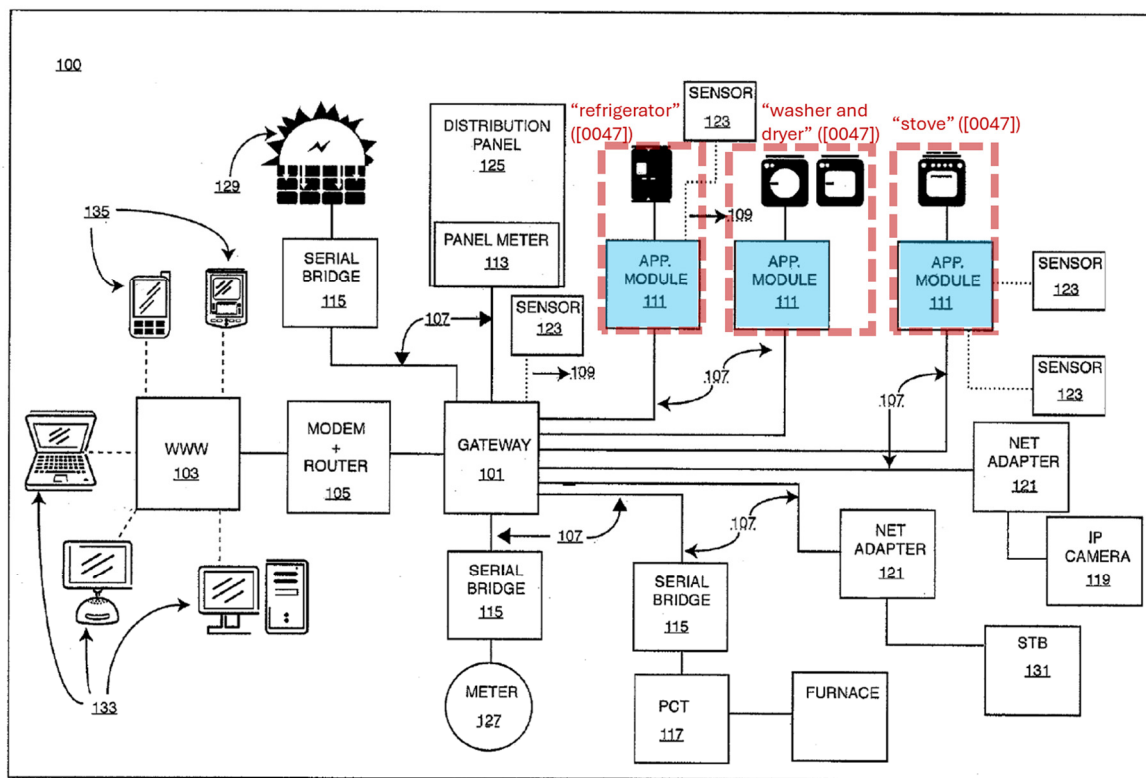
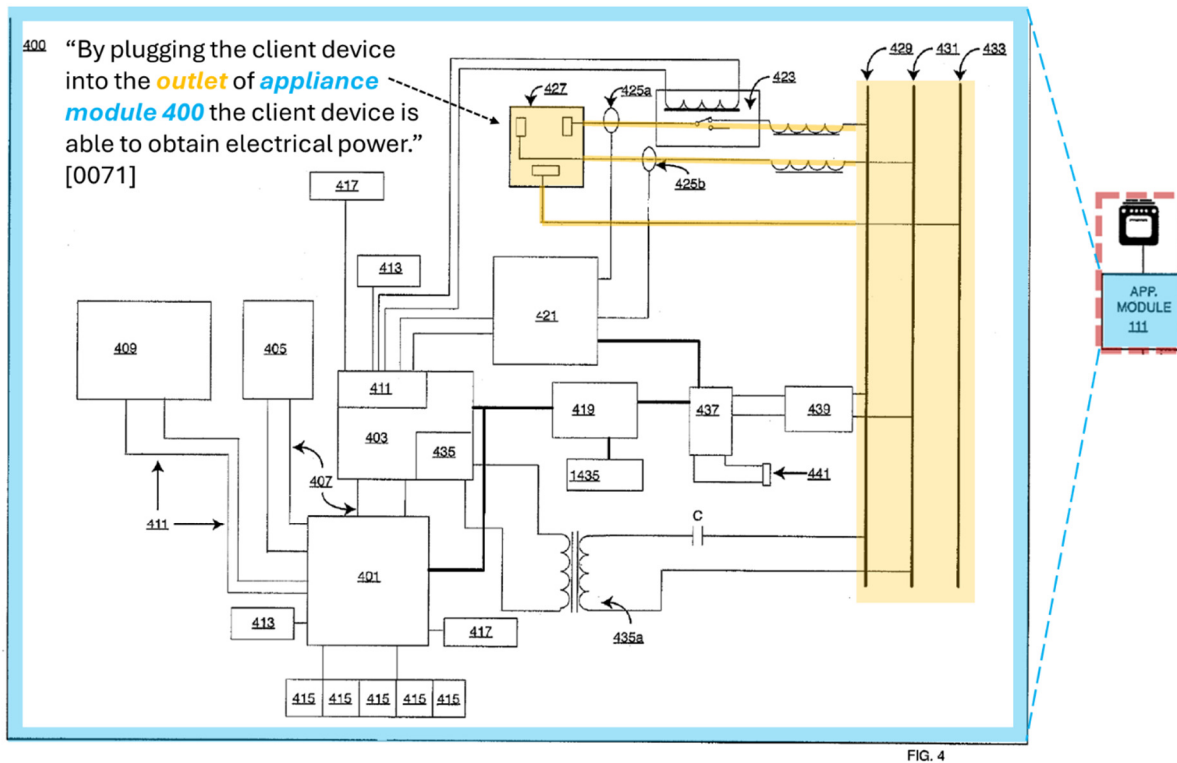


FIG. 1

92. Chan’s appliances are AC-powered. As shown in FIG. 1, each appliance includes an *appliance module 111*. The “*appliance module 400* may sit between a client device [e.g., stove, refrigerator, etc.] and a *standard wall*

electrical outlet.” EX1004, [0071].) As shown in FIG. 4, the *appliance module 400* includes “*a standard AC socket 427*” that “is plugged directly onto the *AC wiring*” including “three wires which include, *a live wire 429, a neutral wire 431 and a ground wire 433.*” (EX1004, [0070].) In this manner, the *appliance module 400* “may be plugged into *an electrical outlet* and ... *simultaneously provide an outlet* to a certain client device.” (EX1004, [0071].) “By plugging the client device into the outlet of *appliance module 400*, the client device is able to *obtain electrical power.*” (EX1004, [0071].) A POSITA would have understood (and found it obvious) that an appliance obtaining electrical power from a “standard wall electrical outlet” via “AC wiring” is AC-powered. (EX1004, [0070].)



b. 1[PR2]: “associated with a food storage, handling, or preparation,”

93. Chan teaches the **appliance** is *associated with food storage, handling, or preparation*. For example, as seen in FIG. 1, “**appliance module[s] 111** can connect to a variety of appliances and devices such as **refrigerator**, washer and dryer, **range, stove, microwave**, personal computer, television, or other appliance.” (EX1004, [0047]; *see also id.*, [0009], [0071].) A **refrigerator** is an appliance associated with food storage and preparation, and **ranges, stoves, and microwaves** are appliances associated with food handling and preparation. Thus, Chan’s appliance—which is a refrigerator, range, stove, or microwave—is associated with food storage, handling, or preparation.

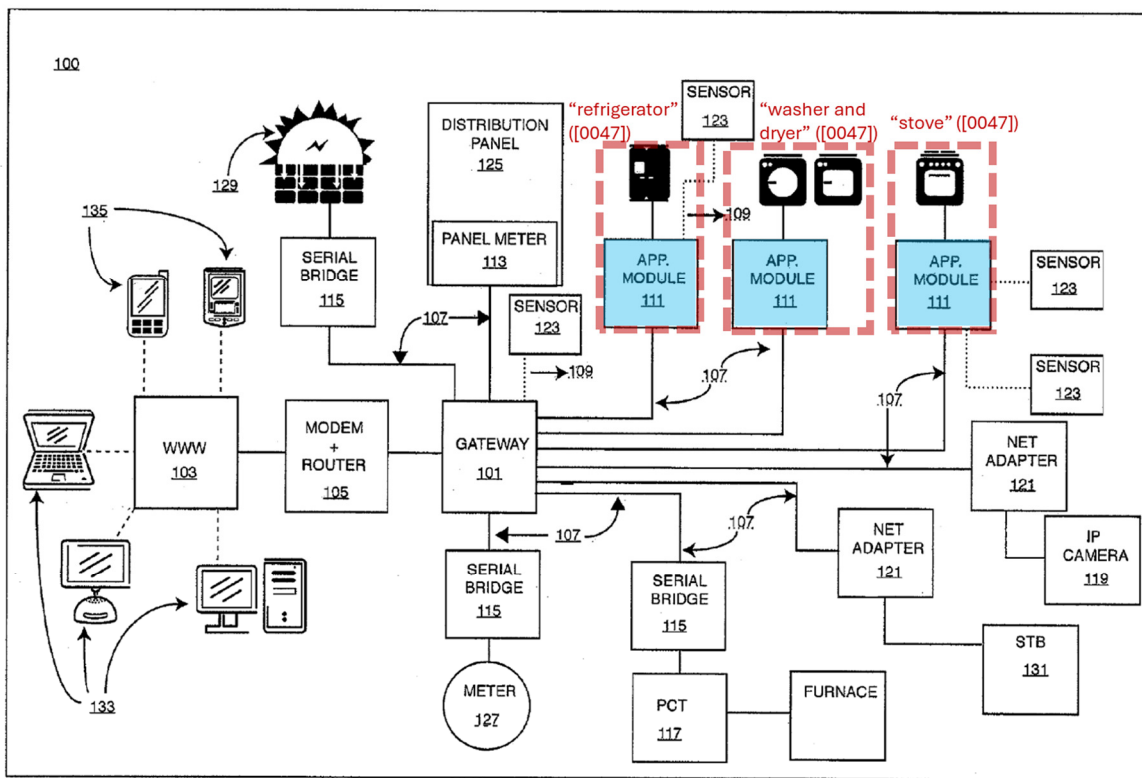
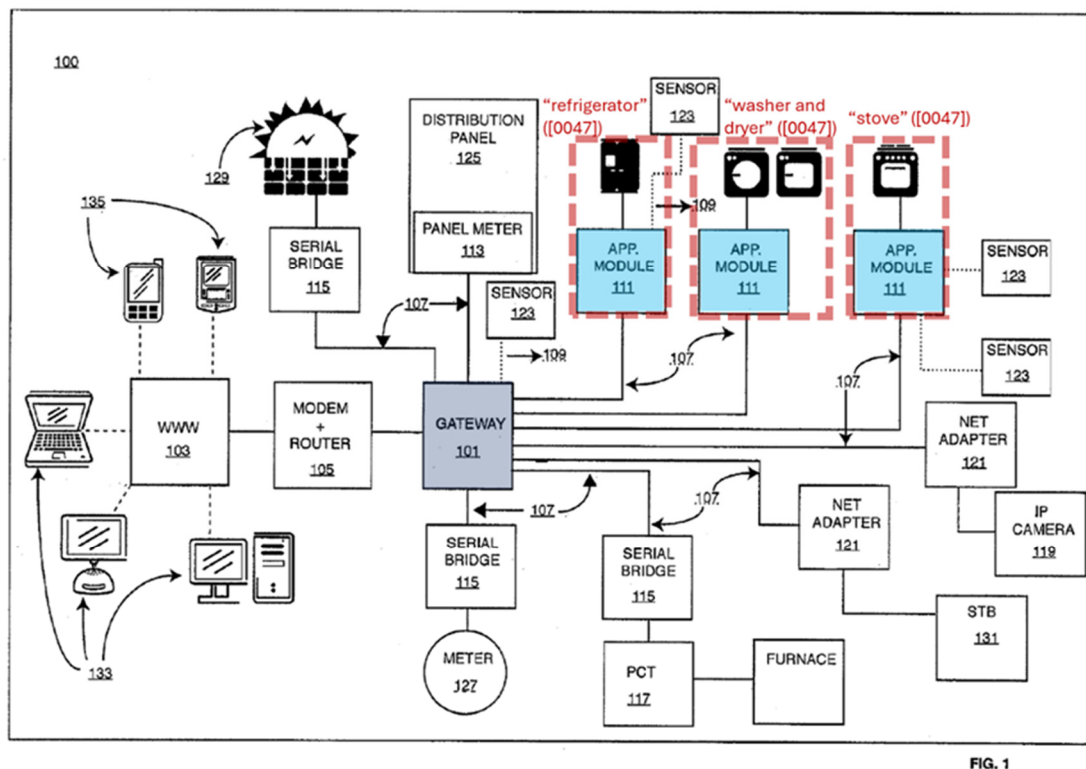


FIG. 1

c. 1[PR3]: “for use with a wireless network, the appliance comprising:”

94. Chan’s *appliance* is for use with a *wireless network*. As shown in FIG. 1, each *appliance* has an *application module 111*, which connects to a *wireless network*. The “*appliance module* [] functions to provide a network backbone across premises wiring and allows *wireless connectivity* to such network backbone.” (EX1004, [0074].) Referring to FIG. 1, a wireless network is formed by *gateway 101* and the appliances including the *appliance modules 111*. (EX1004, [0008], [0053], [0074].) The gateway is a “master control station” that “creates the networking infrastructure needed for connecting a variety of

appliances, devices, controls, and sensors to the World Wide Web.” (EX1004, [0008], [0053].) For example, the gateway is “the central hosting device for ... [the] wireless network” and such “wireless network infrastructure may likewise be supported by *appliance module 111*.” (EX1004, [0053]-[0054].)



95. For example, Chan states that the *application module 111* is “an energy monitor unit for each *appliance load* that plugs into a standard AC wall outlet and monitors power consumption and also has a *wireless transmitter and receiver* for communicating with wireless sensors and devices *on the network*.” (EX1004, [0008].) In other words, each *appliance* is for use with a wireless network because each appliance is connected to an energy monitor unit that uses *a*

wireless transmitter and receiver to communicate with other devices on the wireless network.

96. Further, the *appliance modules 111* “may be adapted to measure, store and or control energy usage of connected *appliances* or devices, bridge Zigbee wireless sensors and devices to the network, or receive and transmit information across network infrastructure.” (EX1004, [0047].)

97. While FIG. 1 shows *gateway 101* and the *appliance modules 111* connected via solid lines, Chan consistently and repeatedly discloses that the connection between *gateway 101* and the *appliance modules 111* is also *wireless*, such that data can be *wirelessly* transmitted between *gateway 101* and the *appliance modules 111*. (EX1004, [0008]-[0009], [0045]-[0046], [0053], [0057], [0073]-[0074], [0111]) For example, the “*appliance module* is configured to turn on or turn off one or more appliances, which are coupled to the control module [of the gateway] using either or *both of wireless module* or the control module.” (EX1004, [0009].) “The powerline data signal sent between appliance module 400 and gateway 300 *may be further transmitted by appliance module 400 as a wireless RF signal*. Additionally, other signal media may be used by appliance module 400 in communicating past the premises wiring system such as *other wireless technologies*, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0073].) “Appliance module software may

control the sending or receiving of data signals across the powerline network *or the wireless network*, or the integrated network infrastructure.” (EX1004, [0111].)

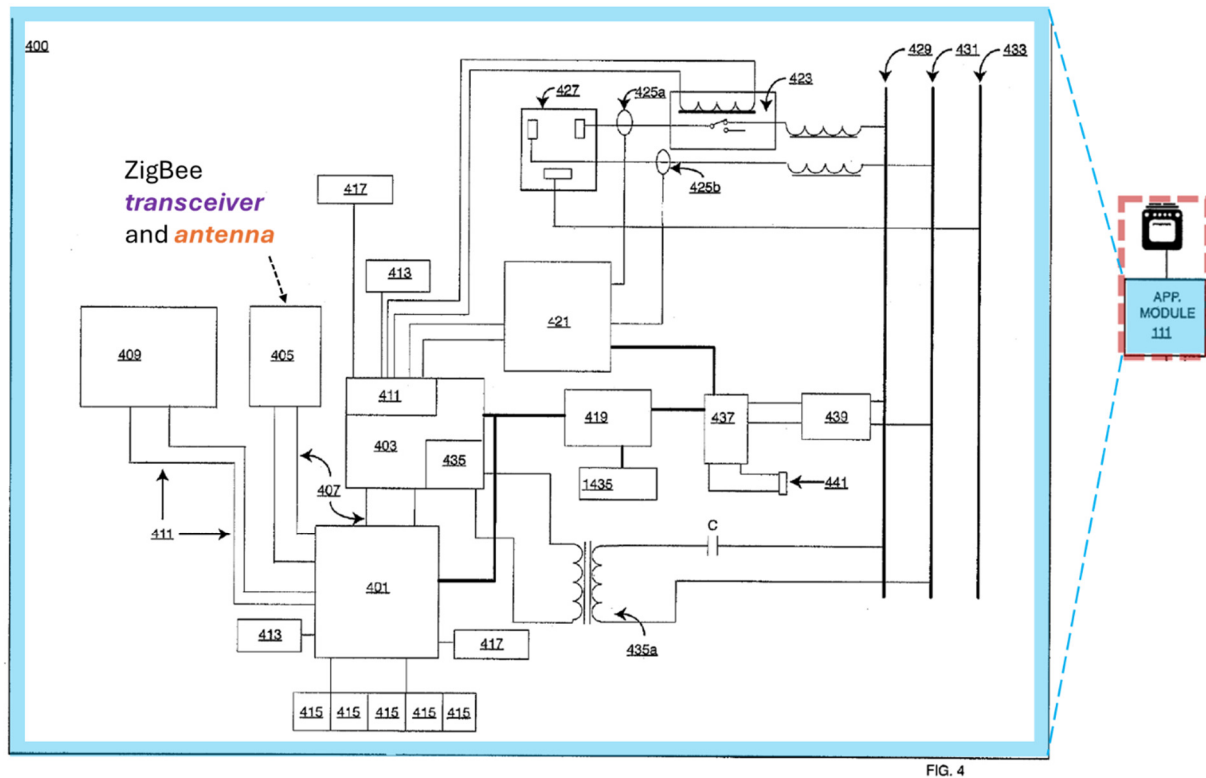
Thus, a POSITA would have understood (and found it obvious) that the connection between *gateway 101* and the *appliance modules 111* is wireless. In other words, the *network infrastructure* encompasses a *wireless infrastructure*.

98. It also would have been obvious to a POSITA to implement such wireless connectivity between *gateway 101* and the *appliance modules 111*. Both components already include wireless communication hardware (*e.g.*, chipsets to support ZigBee, Wi-Fi, Bluetooth, or other wireless technologies). (EX1004, [0070], [0073].) Thus, implementing wireless communication between the *gateway* and *appliance modules* would require no change to the existing hardware configuration or system architecture. A POSITA would have recognized that replacing or supplementing a wired connection with a wireless link would improve installation flexibility, reduce cabling complexity and cost, and enhance scalability by allowing additional appliance modules to be added or repositioned without rewiring. Wireless communication was well-known and routinely used in home automation and energy monitoring systems at the time of the invention to simplify setup and improve user convenience. (*See e.g.*, EX1005, EX1051.) Accordingly, it would have been an obvious and predictable design choice for a POSITA to

implement a wireless connection between Chan's gateway and *appliance modules* to achieve these well-understood advantages.

99. FIG. 4 shows the hardware components of the *appliance module* enabling wireless connectivity. (EX1004, [0070].) As shown, the *appliance module 400* includes “*a Zigbee wireless chipset 405.*” (EX1004, [0070].) Data signals “sent between *appliance module 400* and gateway 300 [*i.e.*, gateway 101 in FIG. 1] may be further transmitted by *appliance module 400* as a wireless RF signal.” (EX1004, [0073].) The *appliance module* may also communicate with the gateway using “other wireless technologies, [such as] WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0073].) A POSITA would have understood (and found it obvious) that these are standard wireless networking protocols. (*E.g.*, EX1001, 4:3-34, 152:18-32.)

100. In this manner, “[*a*] *appliance module 400* enhances the coverage and range of ZigBee or wireless network infrastructure by providing a bridge to the premises wiring network backbone.” (EX1004, [0074].) For example, “[*p*] *reviously un-connected client devices* may be coupled to the network via *appliance module 400.*” (*Id.*) Such client devices able to connect to the wireless network via the *appliance module 400* include “ordinary household *appliance[s].*” (*Id.*)



101. FIG. 11 shows the software components that allow the *appliance module* to connect to the wireless network. (EX1004, [0109].) The *appliance module* includes software that “control[s] the sending or receiving of data signals across the ... *the wireless network*, or the integrated network infrastructure,” allowing “*appliance module* to *provide wireless connectivity* to the powerline network backbone.” (EX1004, [0111].) As an example, Chan discloses that “appliance module software may provide a *client device a wireless connection* to the powerline network.” (*Id.*) As shown in FIG. 11, the *appliance module 1100* includes a driver layer 1103 including a sensor driver and a *Zigbee driver 1117*. (EX1004, [0109].) Such drivers “control the measurement of power usage

information such as instantaneous power, peak power, or average power” and “control sending such data to gateway via network infrastructure.” (EX1004, [0112].) In other words, the appliance is *for use with a wireless network* (such as a ZigBee wireless network) via *Zigbee driver 1117* of *appliance module 1100*.

1100

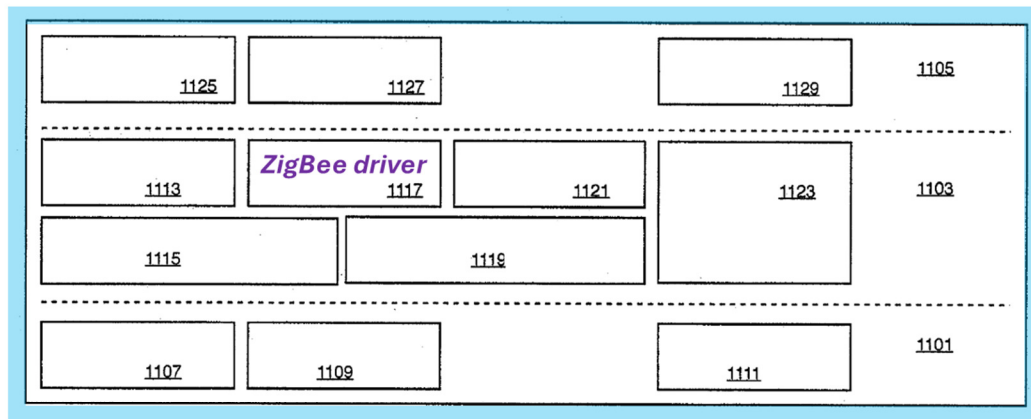
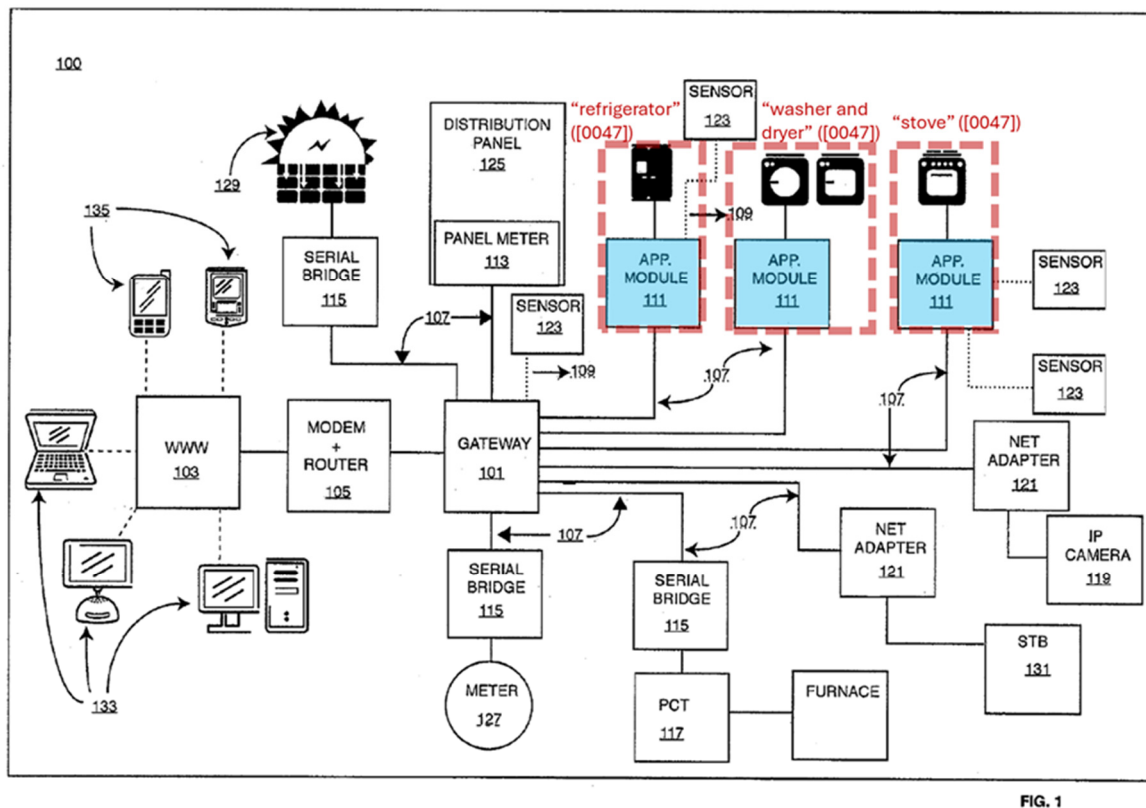


FIG. 11

d. 1[A]: “an AC connector for connecting the appliance to an AC power source;”

102. Chan discloses *an AC connector* for connecting the *appliance* to *an AC power source*. In FIG. 1, each appliance in Chan’s system is equipped with an *appliance module 111* that “may be adapted to measure, store and or control energy usage of connected appliances or devices.” (EX1004, [0008], [0046]-

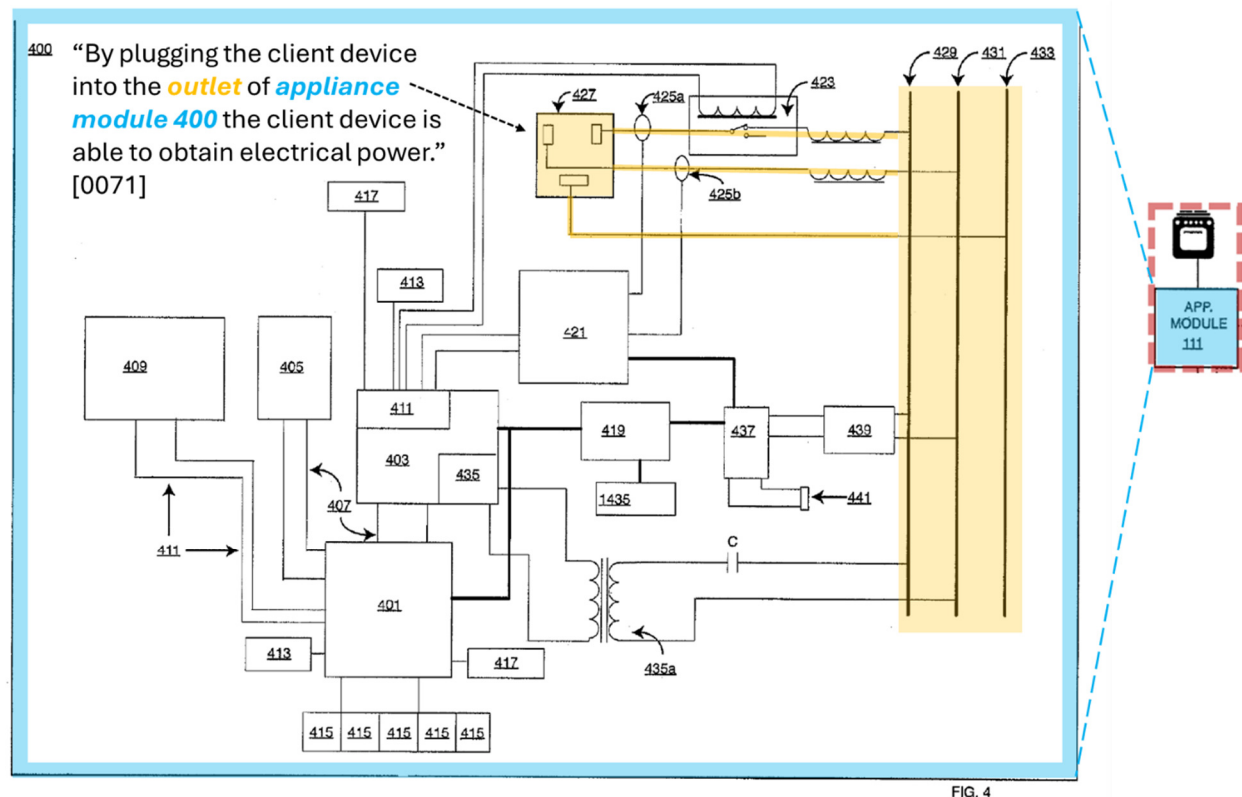
[0047].) In other words, a wall outlet supplies the AC power, and the *appliance* *module* serves as the connector interface that links the *appliance* load to that power source. (EX1004, [0008], [0046]-[0047], [0070]-[0071].)



103. Chan discloses an AC power source. (EX1004, [0070].) The “*appliance module 400* may sit between a client device [*e.g.*, stove, refrigerator, etc.] and a *standard wall electrical outlet*.” (EX1004, [0071].) The *appliance module* includes “*AC wiring*” for connecting to such standard wall electrical outlet. (EX1004, [0070].) A POSITA would have understood (and found it

obvious) that Chan's "standard wall electrical outlet" is an AC power source.
(EX1004, [0070], [0008], [0060], [0071].)

104. FIG. 4 shows the hardware components of *appliance module 400* including an *AC connector* for connecting the appliance to the AC power source (EX1004, [0070].) The appliance module provides "a *standard AC socket 427*" for plugging in the appliance. (EX1004, [0070].) In operation, "*appliance module 400* may be embodied as a device which may be plugged into an electrical outlet [i.e., AC power source] and . . . simultaneously provide an *outlet* [i.e., *standard AC socket 427*] to a certain client device [e.g., stove, refrigerator, etc.]." (EX1004, [0071].)



105. The *appliance module 400* also includes “*AC wiring*,” which is a part of the *AC connector*. “The *AC socket 427* is plugged directly onto the *AC wiring*. *AC wiring* has three wires which include, a live wire 429, a neutral wire 431 and a ground wire 433.” (EX1004, [0070].) In other words, the appliance is plugged into the *appliance module*’s “*AC socket 427*,” which is internally connected to the *appliance module*’s “*AC wiring*.” A POSITA would have understood (and found it obvious) that the “*AC wiring*” is in turn connected to the AC power source (*i.e.*, “standard wall electrical outlet”). (EX1004, [0070]-[0071].) “By plugging the client device [*e.g.*, stove, refrigerator, microwave] into the outlet of *appliance module 400*, the client device is able to *obtain electrical power*.” (EX1004, [0071].)

106. This is consistent with the Board’s mapping of “*AC connector*” during prosecution. In the Decision on Appeal affirming the Examiner’s § 102 rejection of claim 1, the Board agreed that the claimed *AC connector* is disclosed by the configuration shown in Sharood’s FIG. 6d. (EX1003, 189-194.) The Board held, “we find no error in Examiner's reliance on Sharood's *appliance*, which connects to *slots 601 and 602 of retrofit plug 125* (with *outer housing 600* in Figure 6d) which in turn connects to main alternating-current (AC) power supply, as corresponding to the claimed AC powered appliance comprising an AC connector to connect to an AC power source.” (EX1003, 191.)

107. As shown below, Sharood discloses a “*retrofit plug 600*” having “*slots 601 and 602* for connection to the appliance 130, and *pins 603 and 604* to supply mains AC power to the appliance,” as well as *internal wiring 641/643* between the *slots 601/602* and the *pins 603/604*. (EX1003, 192; EX1017, FIG. 6d.) As illustrated below, Chan’s AC configuration is analogous to that of the configuration shown in the prior art, as well as the configuration shown in the representative figure from the ’590 patent itself, both shown below.

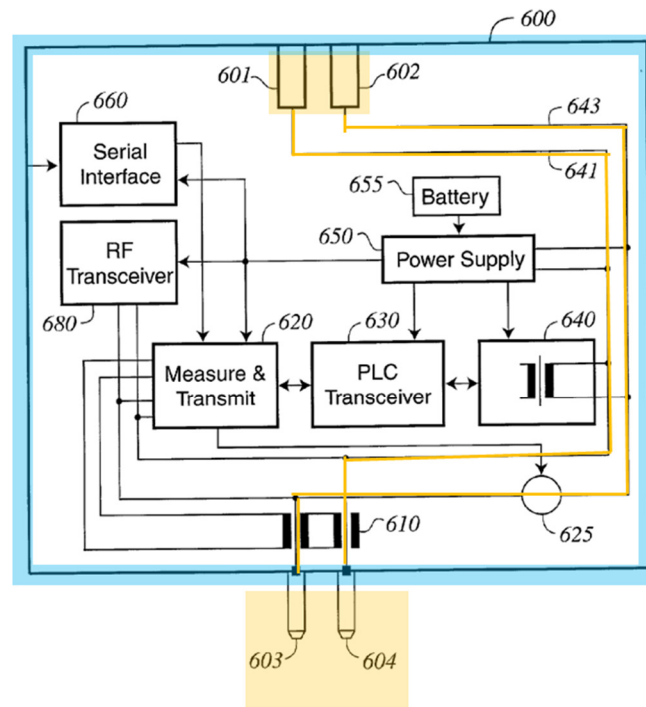


FIG. 6d

(EX1017, FIG. 6d.)

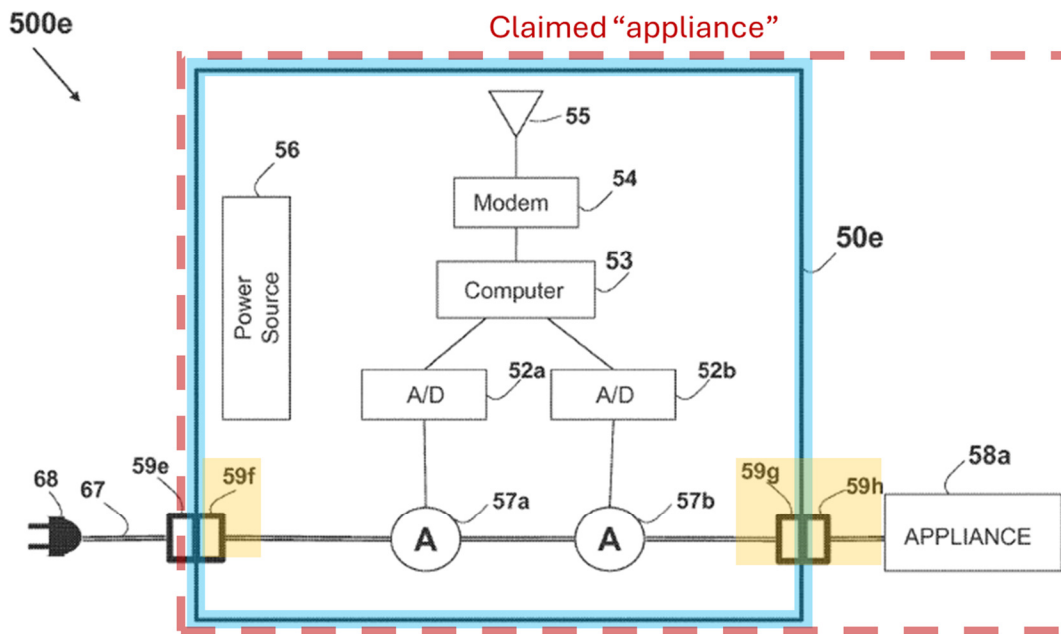
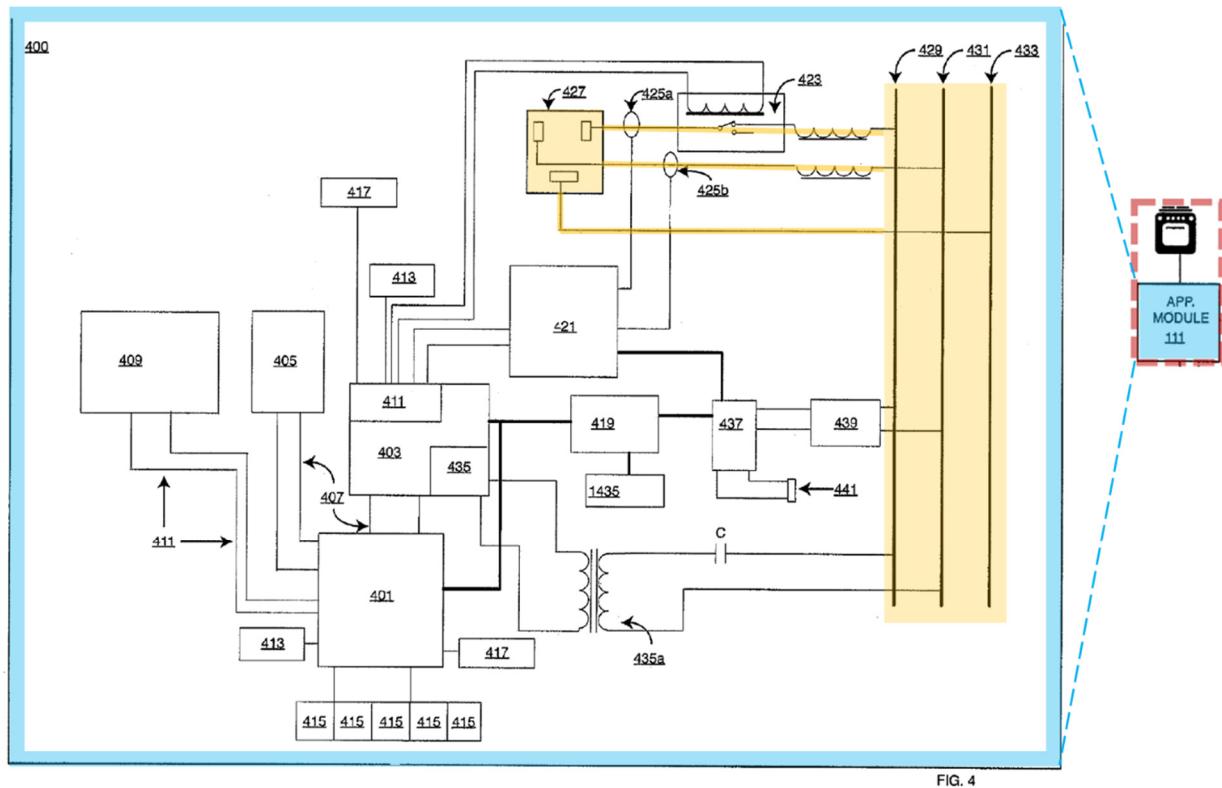


FIG. 5e

(EX1001, FIG. 5e.)



(EX1004, FIG. 4.)

e. 1[B]: “a current sensor coupled to the AC connector for measuring an AC current consumed by the appliance;”

108. Chan discloses *a current sensor* coupled to the *AC connector* for measuring an AC current consumed by the *appliance*. For example, FIG. 1 illustrates a system that includes “an energy monitor unit for each *appliance load that plugs into a standard AC wall outlet and monitors power consumption.*”

(EX1004, [0008].) A POSITA would have understood that power is a function of current (*e.g.*, Power (P) = voltage (V) * current (I) = I^2 * Resistance (R)), such that by measuring the power consumed by the appliance, the energy monitor unit measures the AC current consumed by the appliance. (EX1020, 10.) Further,

Chan explains that each appliance is connected to an “*appliance module 111* [that] may be adapted to *measure, store and or control energy usage* of connected appliances or devices.” A POSITA would have understood (and found it obvious) that to measure power, the *appliance module 111* would measure the current consumed by the appliance. This is at least because energy is power consumed over time (*e.g.*, Energy (E) = V*I*time (t)). (EX1020, 10-11.)

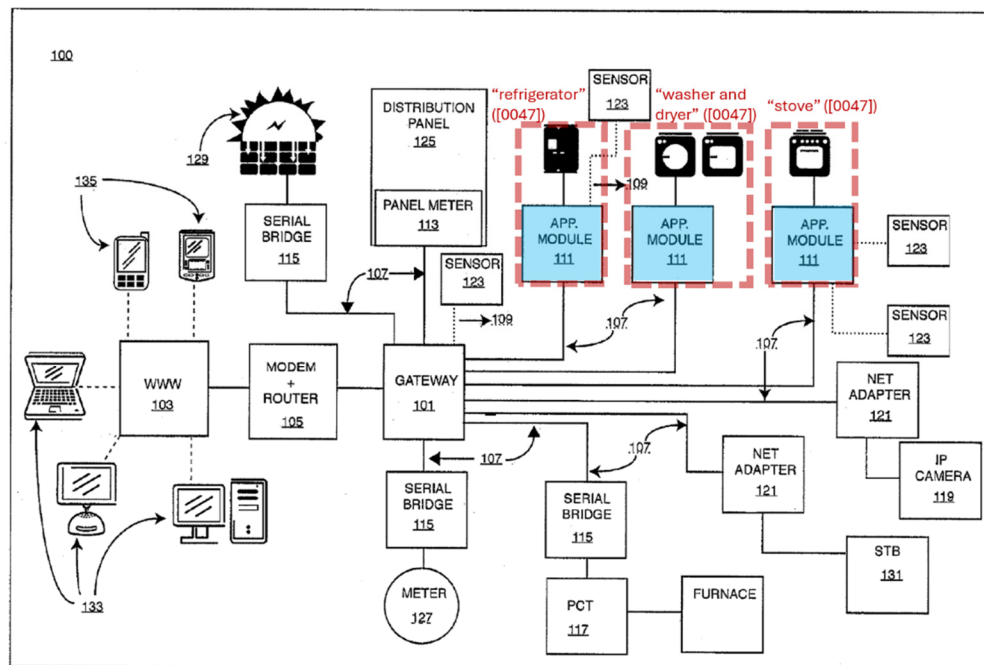


FIG. 1

109. FIG. 4 shows the internal hardware components of the *appliance module*, including a *current sensor* coupled to the *AC connector* for measuring an AC current consumed by the appliance (EX1004, [0070].) The appliance module includes a *current sensor*. Specifically, *appliance module 400* includes a power measure module 421, which “is connected to a power supply 437 and two (2)

current transformers (CT) 425a and 425b.” (EX1004, [0070].) As shown in FIG. 4, “*CT 425a measures current* on the *live wire 429*.” (EX1004, [0070].) As discussed above, the *live wire 429* is part of the “*AC wiring*” of the *AC connector* between the appliance and the wall outlet and thus carries an AC current consumed by the appliance. (EX1004, [0070]; *supra* §IX.A.2.d.) In other words, when an appliance is plugged into the *appliance module*, the load current drawn by that appliance flows through the *live wire 429* where it is measured by *current transformer 425a*. (EX1004, [0070], FIG. 4.) Thus, the current measured by *current transformer 425a* represents the AC load current drawn by the connected appliance (*i.e.*, the amount of AC current the appliance consumes during operation). Accordingly, *current transformer 425a* is a *current sensor* that measures the AC current consumed by the appliance. This way, Chan’s “*appliance module* [] may be adapted to *measure, store and or control energy usage* of connected appliances or devices.” (EX1004, [0047].)

110. Further, the *current sensor* is coupled to the *AC connector* because “*current transformer[] (CT) 425a . . . [is] connected to a standard AC socket 427 [that]... is plugged directly onto the AC wiring.*” (EX1004, [0070].)

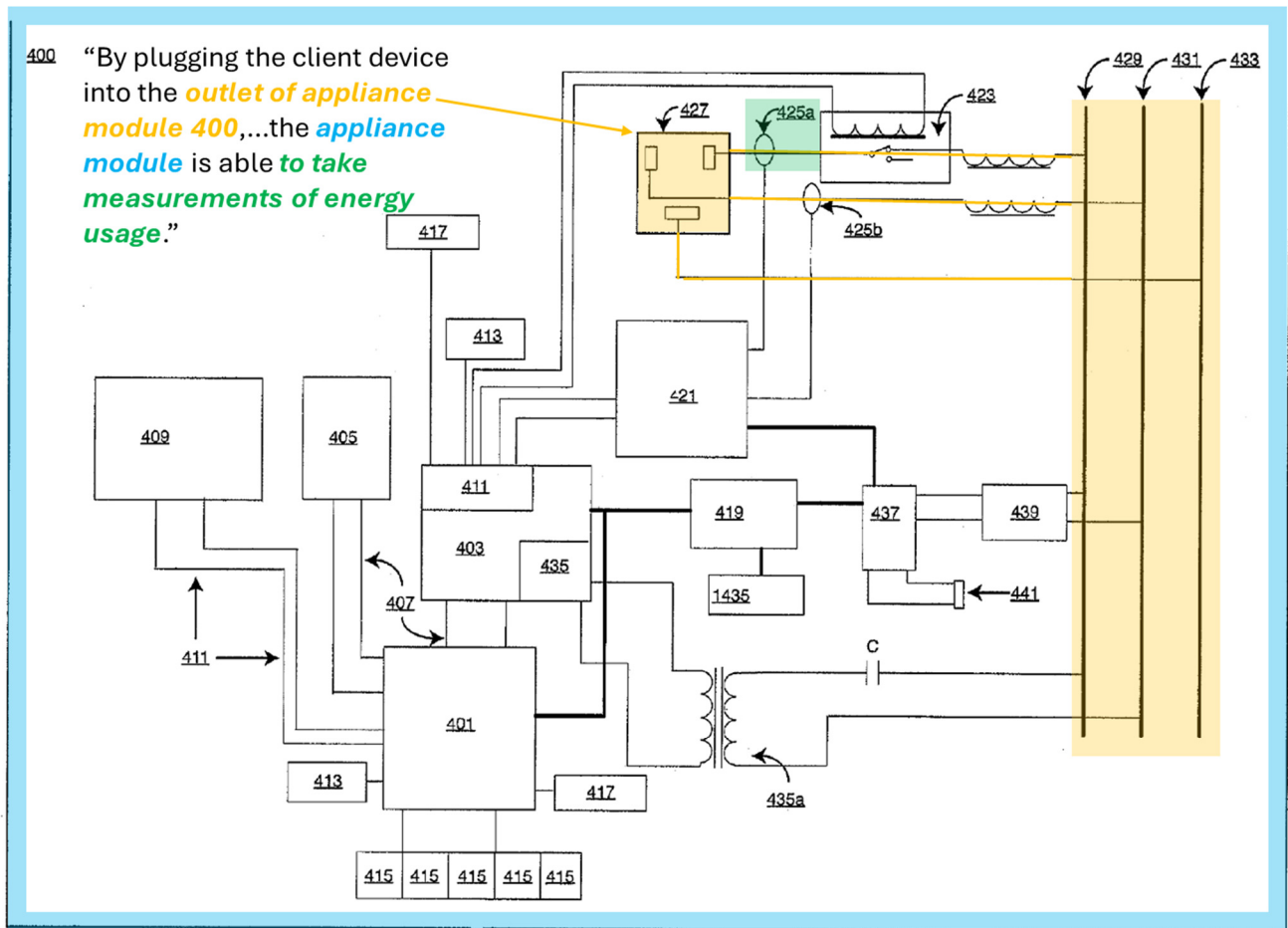


FIG. 4

f. 1[C]: “a first sensor having an output that responds to a physical phenomenon;”

111. I note that the '590 patent defines a **sensor** that responds to a physical phenomenon broadly. For example, the '590 patent states “[a]n appropriate sensor may be adapted for a specific *physical phenomenon*, such as a sensor responsive *to temperature, humidity, pressure, audio, vibration, light, motion, sound*, proximity, flow rate, electrical voltage, *and electrical current*.” (EX1001, 16:44-50; see also *id.* 22:25-34.)

112. Consistent with this definition, Chan discloses a *first sensor* having an output that responds to a physical phenomenon. For example, FIG. 4 shows *appliance module 400* with multiple integrated sensors. (EX1004, [0070].) Chan discloses that *appliance module 400* includes a power measure module 421, which “is connected to a power supply 437 and ...[a] *current transformer[] (CT)* ... *425b* that [is] connected to a *standard AC socket 427*.” (EX1004, [0070].)

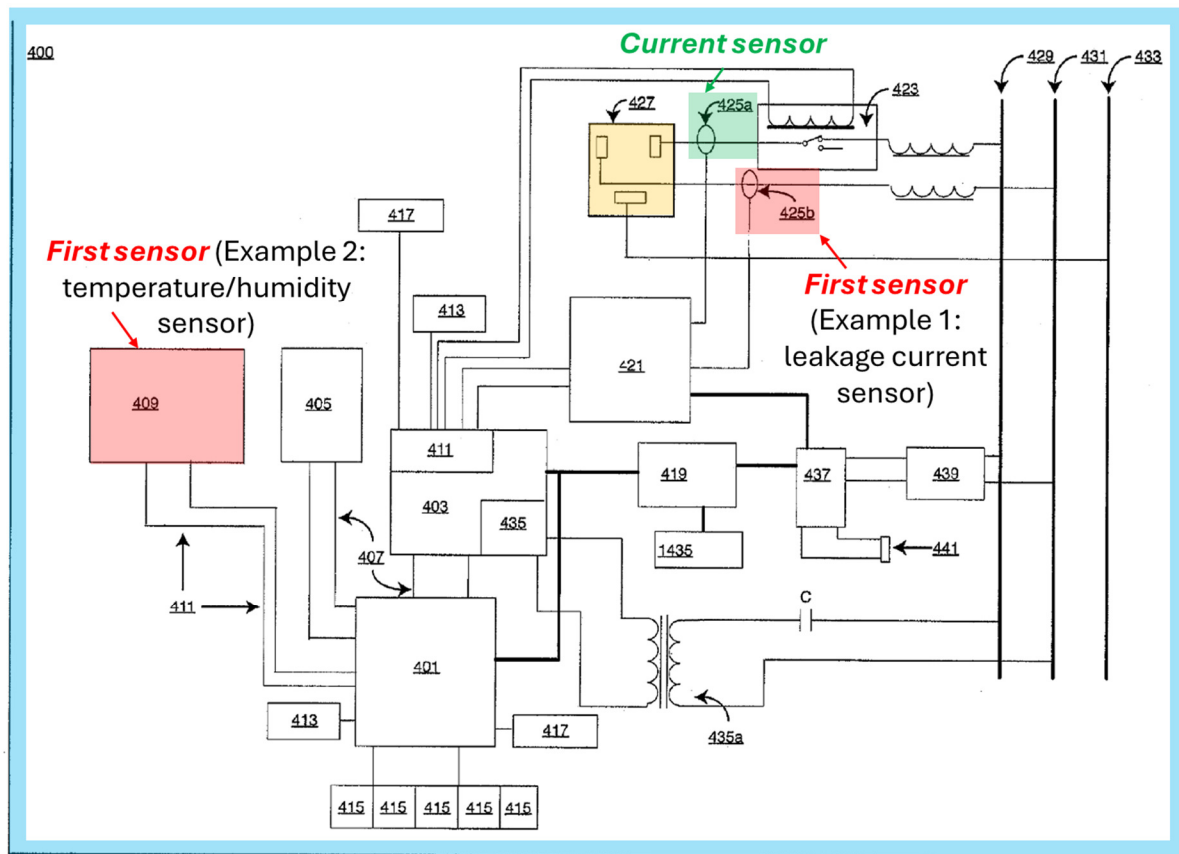


FIG. 4

113. **Current transformer 425b** is a sensor having an output that responds to physical phenomenon. As shown in FIG. 4, “**CT 425b** measures current leakage on the **neutral wire 431**.” (EX1004, [0070].) The ’590 patent explains that

electrical current is a physical phenomenon. (*See, e.g.*, EX1001, 16:44-50 (“An appropriate sensor may be adapted for a *specific physical phenomenon*, such as a sensor responsive to . . . *electrical current*.”).)

114. Chan also identifies other *first sensors* within the same appliance module enclosure. For example, *appliance module 400* includes a “a *temperature and humidity sensor 409*.” (EX1004, [0070].) Temperature and humidity are physical phenomena. (*See* EX1001, 16:44-50 (“An appropriate sensor may be adapted for a specific *physical phenomenon*, such as a sensor responsive to *temperature, humidity . . .*”).)

115. Additionally, with reference to FIG. 11, Chan describes “a simplified software block diagram 1100 for the *appliance module*,” where the physical layer 1101 includes “a *temperature/fog/brightness/infrared sensor 1107*, a *switch/relay/alarm sensor 1109*, and a powerline interface 1111.” (EX1004, [0109].) The specification explains that “data measurements at the appliance module may be controlled by appliance module software.” (EX1004, [0112].) These disclosures confirm that the application module integrates multiple sensors, each producing an output responsive to temperature, fog, light, or other environmental phenomena.

1100

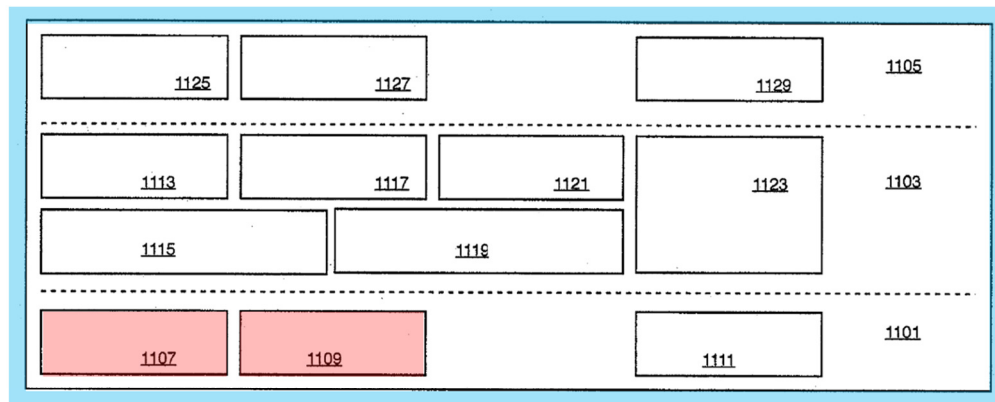


FIG. 11

116. Furthermore, in claims 3-16, Chan discloses an “*appliance module* comprising a *thermal sensor*,” “a *humidity sensor*,” “a *security sensor*,” “a *motion sensor*,” “a *light sensor*,” “one or more *motion sensors*,” “one or more *pressure sensors*,” “one or more *microphones*,” “one or more *vibration sensors*,” “a *gyro* or *accelerometer*,” “one or more *smoke sensors*,” “*biological sensors*,” or “one or more *combinations of sensor devices*.” (EX1004, Claims 3-16.) These all have outputs responsive to physical phenomena, consistent with the patent. (See EX1001, 16:44-50 (“An appropriate sensor may be adapted for a specific *physical phenomenon*, such as a sensor responsive to *temperature*, *humidity*, *pressure*,

audio, vibration, light, motion, sound, proximity, flow rate, electrical voltage, and electrical current.”.) These claims therefore confirm that the *appliance module* include a multitude of *sensors* that meet the requirement of “a *first sensor* having an output that responds to a physical phenomenon.”

g. 1[D]/1[E]: “an antenna for communication over the wireless network; a wireless transceiver coupled to the antenna for transmitting digital data to, and for receiving digital data from, the wireless network; and”

117. Chan discloses an *antenna coupled to a wireless transceiver* for communication *over the wireless network*. The hardware allowing wireless connectivity is shown in FIG. 4, which depicts *appliance module 400*. Chan explains that “*appliance module 400* may provide the network infrastructure to support connectivity between gateway 300 and client devices,” and that “*appliance modules 400* may communicate to client devices wirelessly via RF signal past the premises wiring system.” (EX1004, [0073].) Chan further discloses that “the powerline data signal sent between appliance modules 400 and gateway 300 may be further transmitted by appliance modules 400 as a wireless RF signal,” and that “other signal media may be used ... such as wireless technologies, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0073]; *see also id.*, [0072], [0074]-[0076].)

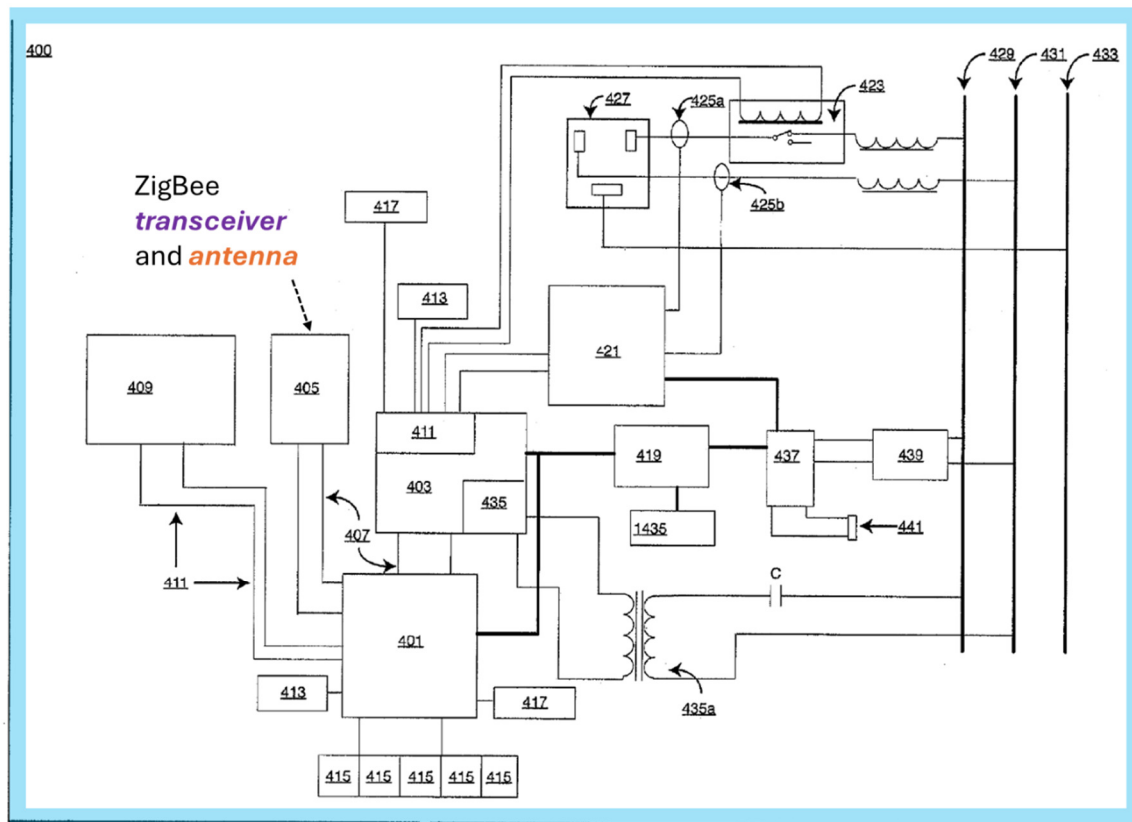


FIG. 4

118. In FIG. 4, the *appliance module 400* includes a “*Zigbee wireless chipset 405*.” (EX1004, [0070].) A POSITA would have understood (and found it obvious) that the *Zigbee wireless chipset 405* to include an *antenna* coupled to a *wireless transceiver* for communicating with the wireless network. (EX1016, 34.) Equipped with a “*Zigbee wireless chipset 405*,” appliance module is a ZigBee device. (EX1004, [0070].) And it was well-known that “[a] ZigBee network consists of ZigBee nodes (devices)” and each ZigBee device “consists of a microcontroller, a *transceiver*, and an *antenna*.” (EX1016, 34.)

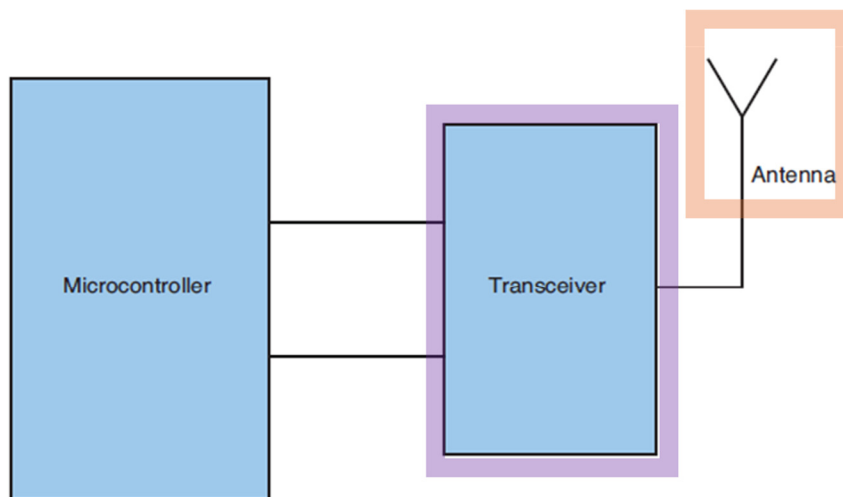


Figure 2.1 Architecture of ZigBee node

(EX1016, 34, FIG. 2.1.)

119. Thus, the POSITA would have understood (and found it obvious) that *Zigbee wireless chipset 405* includes an *antenna coupled to a wireless transceiver* to enable the wireless communication described by Chan. (EX1016, 34.)

120. ZigBee is merely one wireless communication method in Chan. The *appliance module* also communicates using a number of “other wireless technologies, [such as] WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0073].) Further, it was well-known that “wireless communication requires a *transmitter (transmitter electronics plus antenna)* generating (electromagnetic) signals that can be properly received and deciphered by a *receiver (receiving electronics plus antenna.)* A “*transceiver* consists of a *transmitter* and a *receiver*.” (EX1018, 369.) “The mobile WLAN device 12a includes a WLAN transceiver 20 operatively coupled to antenna 22 and

processing circuitry 24 operatively coupled to the WLAN transceiver to send and receive suitable information via a WLAN protocol.” (EX1022, 3:17-20, 3:38-40; *see also*, EX1023, [0013]-[0015].) Thus, the POSITA would have understood (and found it obvious) that, to implement these wireless communication technologies disclosed in Chan, the *appliance module* includes an *antenna* coupled to a *wireless transceiver*. (EX1018, 369.)

121. Chan’s system-level description is consistent with this hardware implementation. FIG. 1 illustrates system 100, in which the gateway 101 connects to external data sources and communicates with client devices (such as *appliance modules 111*) “through AC wiring 107 or *wirelessly 109*.” (EX1004, [0045].) Chan also explains that “the gateway 101 is adapted to bridge low speed and high-speed powerline technologies and *ZigBee wireless technology* together,” and that “wireless technology can include other wireless technologies *such as wireless 802.11 standards, Zwave, 6lowPAN, or others*.” (EX1004, [0046]; *see also id.*, [0004], [0008]-[0009].) In particular, “the system further includes an energy monitor unit for each appliance load that plugs into a standard AC wall outlet and monitors power consumption and also has a *wireless transmitter* and *receiver* for communicating with wireless sensors and devices on the network.” (EX1004, [0008].) A POSITA would have understood these transmitters and receivers correspond to, for example, ZigBee wireless chipset 405 shown in FIG. 4.

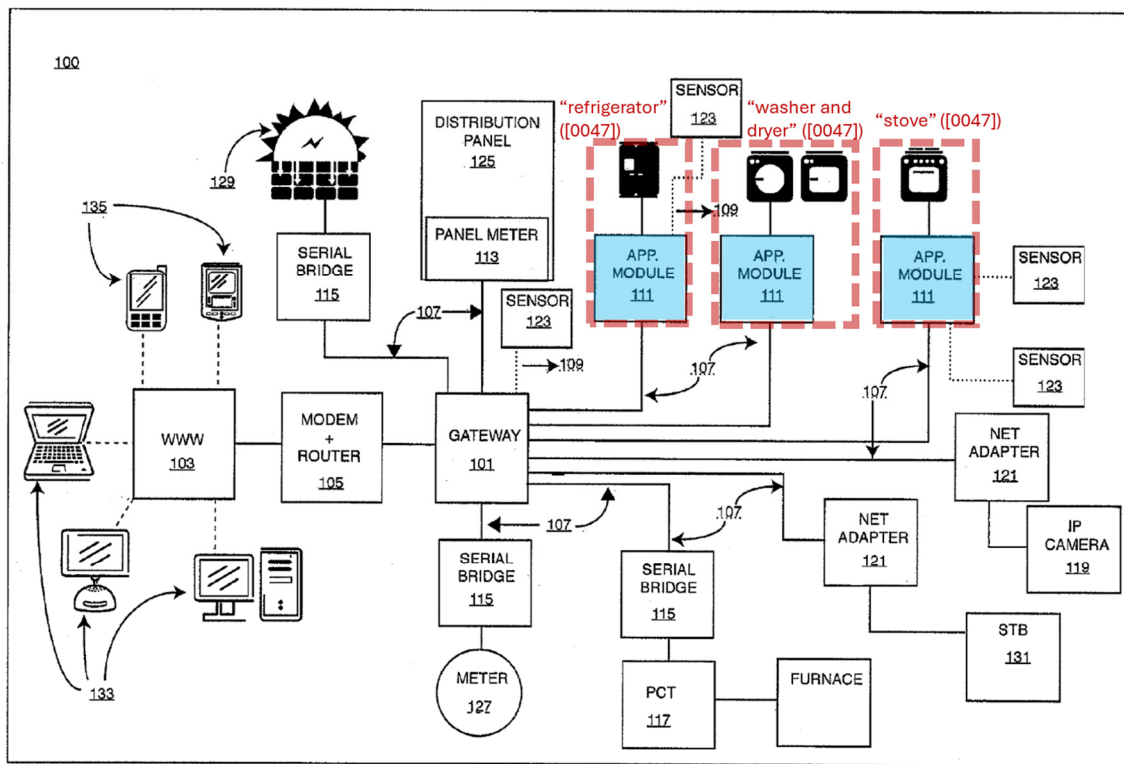


FIG. 1

122. Chan also explains that *appliance modules 111* “may be adapted to ... *bridge Zigbee wireless sensors and devices to the network, or receive and transmit information across network infrastructure.*” (EX1004, [0047].) For example, Chan discloses that “[t]he *wireless network infrastructure* may likewise be supported by *appliance module 111*, or various wireless routers, switches, or signal amplifying devices across *the wireless coverage area.*” (EX1004, [0053].) Collectively, these disclosures confirm that both the gateway and appliance modules include antennas coupled to wireless transceivers that enable the wireless communication utilized by Chan’s networked system.

123. Chan teaches that the *antenna* is for *communication* over the wireless network and the *wireless transceiver* is for *transmitting digital data to* the wireless network. As discussed above, referring to FIG. 1, the wireless network is formed by gateway 101 and the *appliance modules 111*. (EX1004, [0074].)

124. For example, Chan teaches “[d]ata measured by *appliance module 400* as a preferred embodiment includes power usage information, such as instantaneous power, peak power, or average power” and that “[a]*appliance module 400 sends* such data *to gateway 300* via *network infrastructure*.” (EX1004, [0075].) Chan explains that “[t]he powerline data signal sent between *appliance module 400* and gateway 300 may be further transmitted by *appliance module 400* as a wireless RF signal” or “other wireless technologies, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0073].) That is, the *antenna* and *transceiver* of the *appliance module* *transmit* sensor and power data to the wireless network.

125. Chan also teaches that the *antenna* and the *wireless transceiver* *receive digital data from* the wireless network. For example, Chan teaches “coupling by gateway 300 to *client devices* [such as *appliances* including *appliance modules 111*] is accomplished with ... *wireless signal technology*.” For example, “a low-bandwidth signal may carry command or control information *from* gateway 300 *to appliance module 111* and turn the connected appliance on or

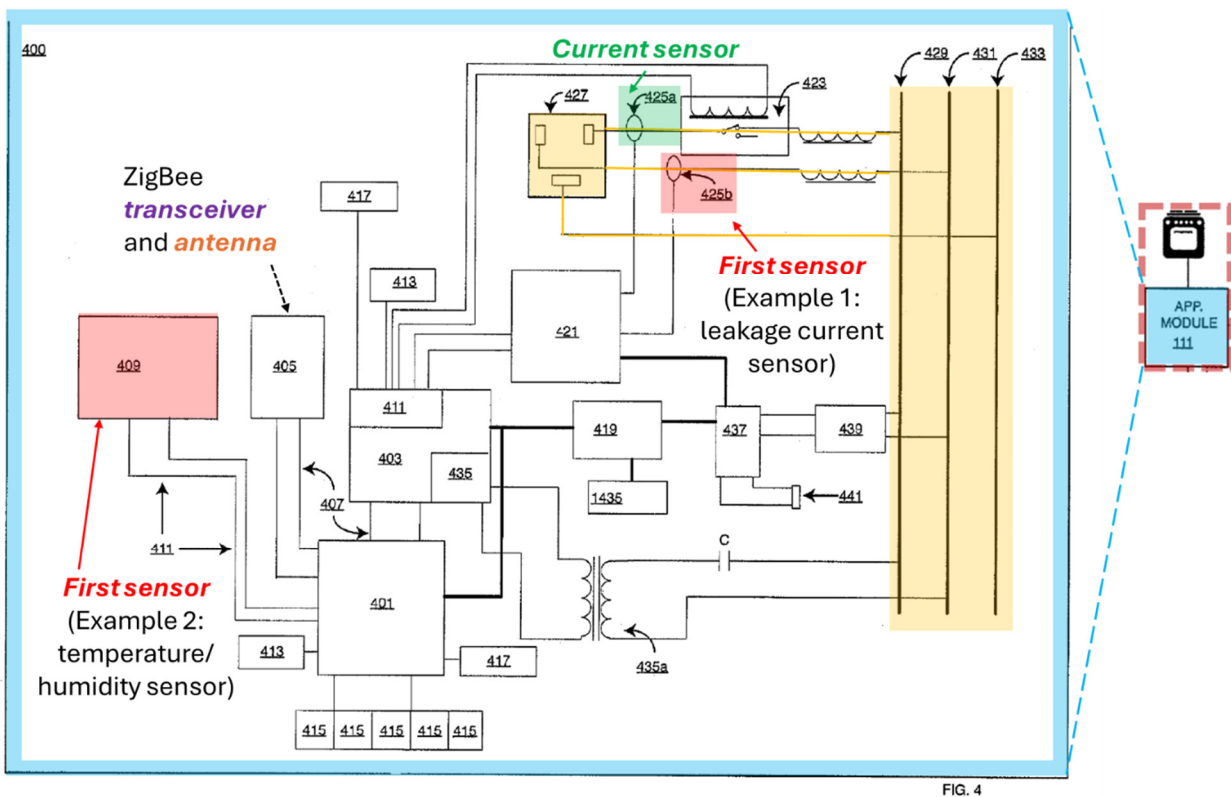
off.” (EX1004, [0057].) In other words, the *antenna* and the *wireless transceiver* of the *appliance module receive* data from the wireless network for controlling the *appliance*.

126. This is consistent with Chan’s broader network architecture. For example, appliance module 111 “may be adapted to ... *receive and transmit* information across network infrastructure.” (EX1004, [0047].) Accordingly, the *appliance modules 111* include *wireless transceivers* coupled to *antennas* for transmitting digital data to, and for receiving digital data from, the wireless network.

127. A POSITA would have understood (and found it obvious) that data received and transmitted by the *wireless transceiver* is *digital*. Chan specifies that the CPU communicates with the ZigBee wireless chipset through an *RS-232 serial interface* 407. (EX1004, [0070].) RS-232 serial interfaces transmit binary data in a bitwise fashion (*e.g.*, are digital communication links), confirming that the information sent to and from the ZigBee chipset 405 is *digital*. (EX1019, 1.) This is consistent with the ’590 patent’s own statement that “ZigBee is a specification for a suite of high-level communication protocols using small, low-power *digital radios* based on an IEEE 802 standard for personal area networks.” (EX1001, 4:3-16.)

h. 1[F]: “a single enclosure housing the current sensor, the first sensor, the antenna, and the wireless transceiver,”

128. Chan discloses a *single enclosure* housing the *current sensor*, the *first sensor*, the *antenna*, and the *wireless transceiver*. FIG. 4 provides a detailed view of *appliance module 400*, expressly showing the claimed elements are housed within. For example, within that enclosure, FIG. 4 depicts “two (2) current transformers (CT) *425a* and *425b* that are connected to a standard AC socket *427*,” and a “*ZigBee wireless chipset 405*” (including the *wireless transceiver* and *antenna*). (EX1004, [0070].) Each of these elements is physically contained within the same *appliance module* housing.



129. The POSITA would have understood (and found it obvious) the appliance module to be a single, self-contained device that houses its functional components. The *appliance* module 400 is consistently described as a single device rather than a set of distributed parts. For example, Chan explains that “[a] preferred embodiment of appliance module 400 is *a device* which can connect to a variety of appliances or devices and measure, store or control energy usage of each appliance or device.” (EX1004, [0071].) Chan further explains that “as an example of appliance module placement, appliance module 400 may sit between a client device and a standard wall electrical outlet. Specifically, appliance module 400 may be embodied as a *device* which may be plugged into an electrical outlet and ... simultaneously provide an outlet to a certain client device.” (*Id.*) A POSITA would have understood (and found it obvious) that appliance module, as a device, would have a device housing enclosing its parts.

130. Indeed, “the appliance module 111 may be a product manufactured by Jetlun Corporation . . . under the part number RD75613.” (EX1004, [0047].) As shown by the RD75613 User Manual, the *appliance module* is a single device enclosing its parts. (EX1043, FIG. 1.)

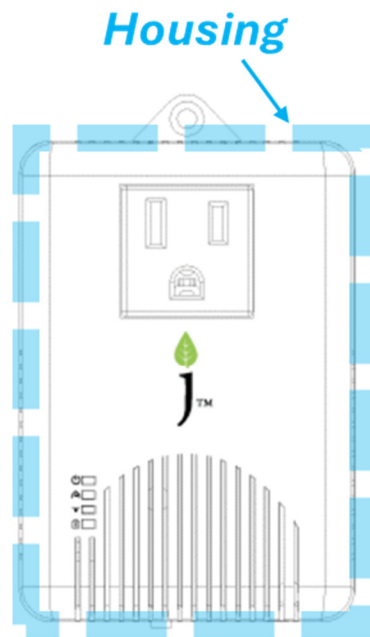


Figure 1: Front Panel of the Appliance Module

131. Within that single enclosure, the specific components disclosed correspond directly to the elements recited in the claim. As discussed above, *CT 425a* functions as the *current sensor* measuring the current consumed by the appliance, and *CT 425b* function as the *first sensor* having an output that responds to a physical phenomenon. The *ZigBee wireless chipset 405* includes both the *wireless transceiver* and the *antenna* used for communication with the wireless network. Thus, Chan's *appliance module 400* integrates all four claimed components within a single housing.

132. The configuration shown in FIG. 4 of Chan aligns with the '590 patent's own disclosure. The '590 patent explains, when describing FIG. 5e, that

“the *sensor unit 50e* corresponds to the sensor unit 50 shown in FIG. 5, where the two sensors *51a* and *51b* are used to sense the same phenomenon.” (EX1001, 84:15-33.) In FIG. 5E, those sensors are two ampermeters *57a* and *57b* that “measure the current flow from the AC power source via the power plug 68 to the appliance 58a.” (*Id.*) Likewise, Chan’s *appliance module 400* includes two current transformers *425a* and *425b* that measure current on the live and neutral conductors of the appliance circuit.

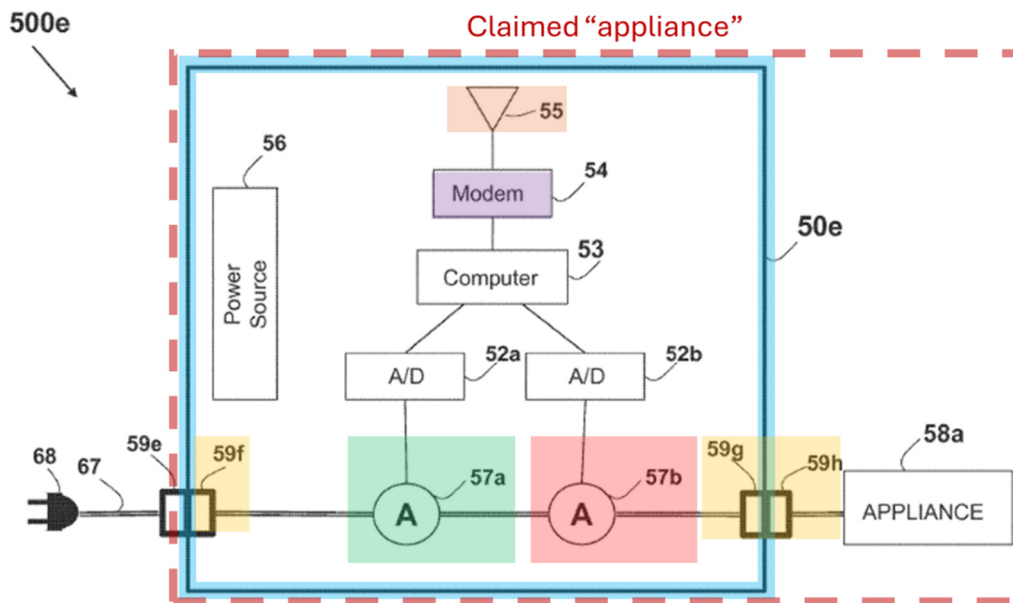


FIG. 5e

133. This is also consistent with the Board’s reasoning in the August 22, 2021, decision on appeal. (EX1003, 189-193.) There, the Board explained that “the appliance is recited, quite broadly, as merely comprising the single enclosure, but not being enclosed within the single enclosure or enclosing the single

enclosure. To the contrary, although open-ended, Claim 1 requires only that the single enclosure houses ‘the current sensor, the antenna, and the wireless transceiver.’” (EX1003, 193.) The Board further observed that “Appellant refers to the claimed appliance as corresponding to item 50e or 58a in Figure 5e ... thus exemplifying the arrangement as claimed featuring the appliance 58a ... as separate from the single enclosure 50e.” (*Id.*) These findings support the same reading here: an appliance plugged into an appliance module that contains the sensors and communication hardware constitutes “an appliance comprising a single enclosure housing” the recited components.

i. 1[G]: “wherein the first sensor is coupled to the wireless transceiver for transmitting digital data in response to the physical phenomenon to the wireless network,”

134. Chan discloses that the *first sensor* is *coupled* to the *wireless transceiver* for *transmitting digital data in response to* the physical phenomenon to the wireless network.

135. First, Chan’s FIG. 4 shows the *coupling* of the *first sensor* to the *wireless transceiver*. For example, FIG. 4 shows that *appliance module 400*, includes “a Central Processing Unit (CPU) 401 that *is connected to* a powerline chipset 403 and a ZigBee wireless chipset 405 *through a RS232 serial interface 407*,” and “a power measure module 421 [that] *is connected to* a power supply 437

and two (2) **current transformers (CT)** 425a and **425b** that **are connected to a** standard AC socket 427.” (EX1004, [0070].)

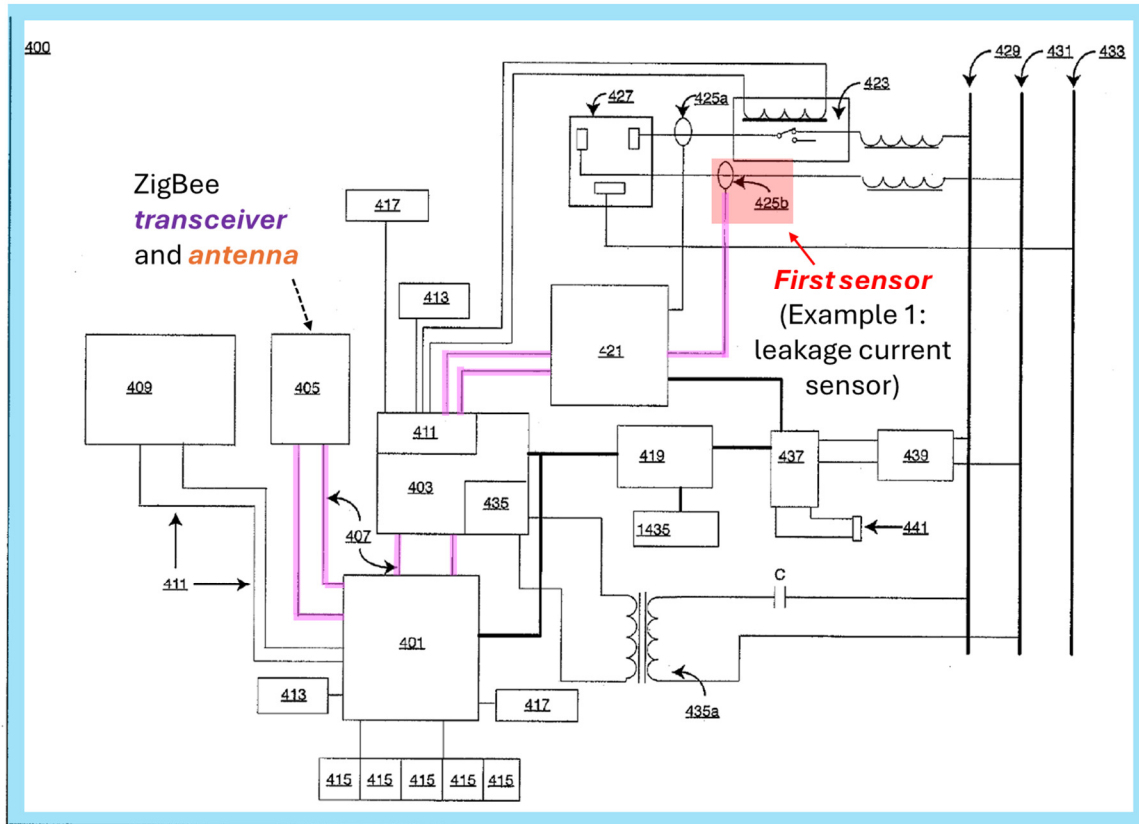


FIG. 4

136. The **current transformer 425b** (e.g., a leakage current sensor) **is coupled to the wireless transceiver**. As shown in FIG. 4, the **current transformer 425b** (e.g., the “**first sensor**”) is **coupled to the CPU 401 through the power measure module 421 and powerline chipset 403**, and the CPU 401 **communicates with the ZigBee wireless chipset 405** (including the **wireless transceiver**) via **the RS232 serial interface 407**. Thus, **CT 425b is coupled** (through these intermediary components) to the **ZigBee wireless chipset 405**, which includes **the**

wireless transceiver of the *appliance module 400*, as described above. (EX1004, [0070].) Such intermediary coupling between the *first sensor* and the *wireless transceiver* is consistent with the coupling in the '590 patent, which shows *ampermeter 57b* and *modem 54* coupled through a computer. (EX1001, FIG. 5e.)

137. FIG. 4 also shows the *temperature and humidity sensor 409* coupled to the *wireless transceiver through* the CPU 401 and the RS-232 serial interface 407. (EX1004, [0070], FIG. 4.)

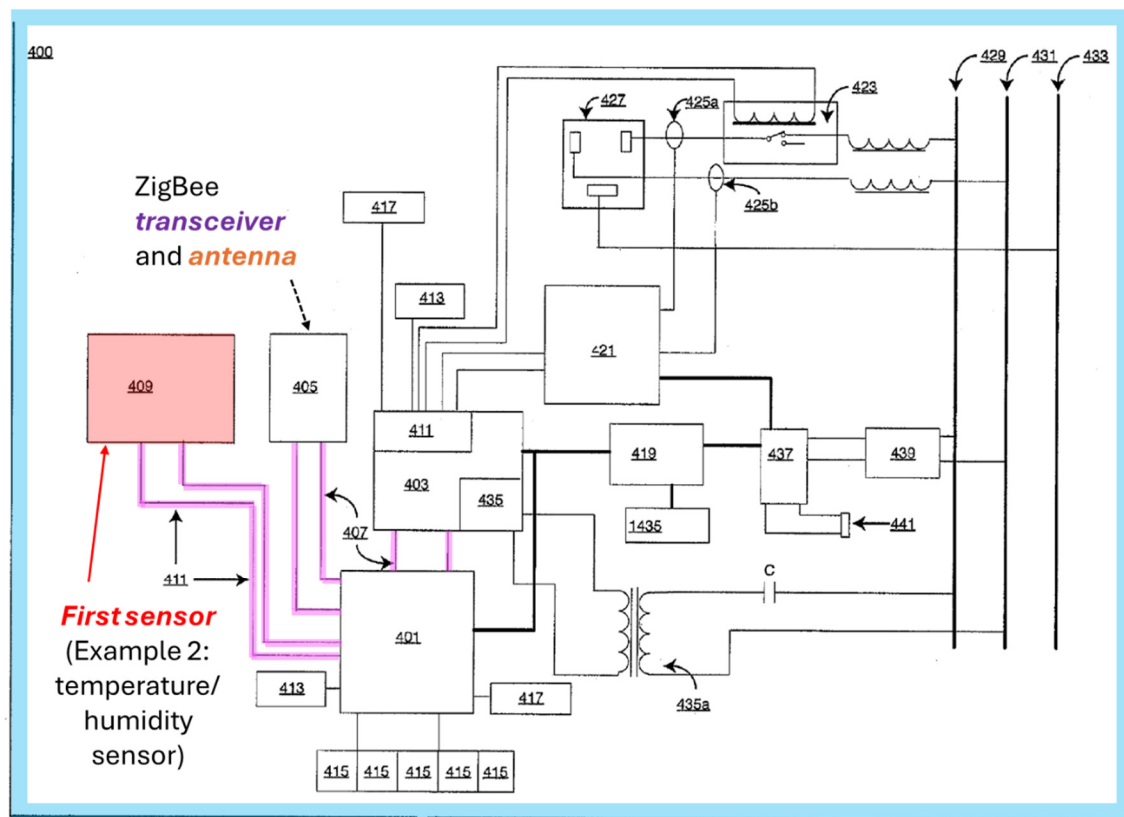


FIG. 4

138. Second, Chan discloses that the *wireless transceiver transmits sensor data* using a wireless network. For example, Chan discloses a system including

appliance modules that “may *send* and receive *data* across the integrated network in relation to a particular appliance.” (EX1004, Abstract.) As shown in FIG. 1, system 100 illustrates a system that includes “[a]n *appliance module 111* [which] can connect to a variety of appliances and devices such as refrigerator, washer and dryer, range, stove, microwave, personal computer, television, or other appliance,” and that “an *appliance module 111* may be adapted to measure, store and or control energy usage of connected appliances or devices, bridge Zigbee wireless sensors and devices to the network, *or receive and transmit information across network infrastructure.*” (EX1004, [0047].)

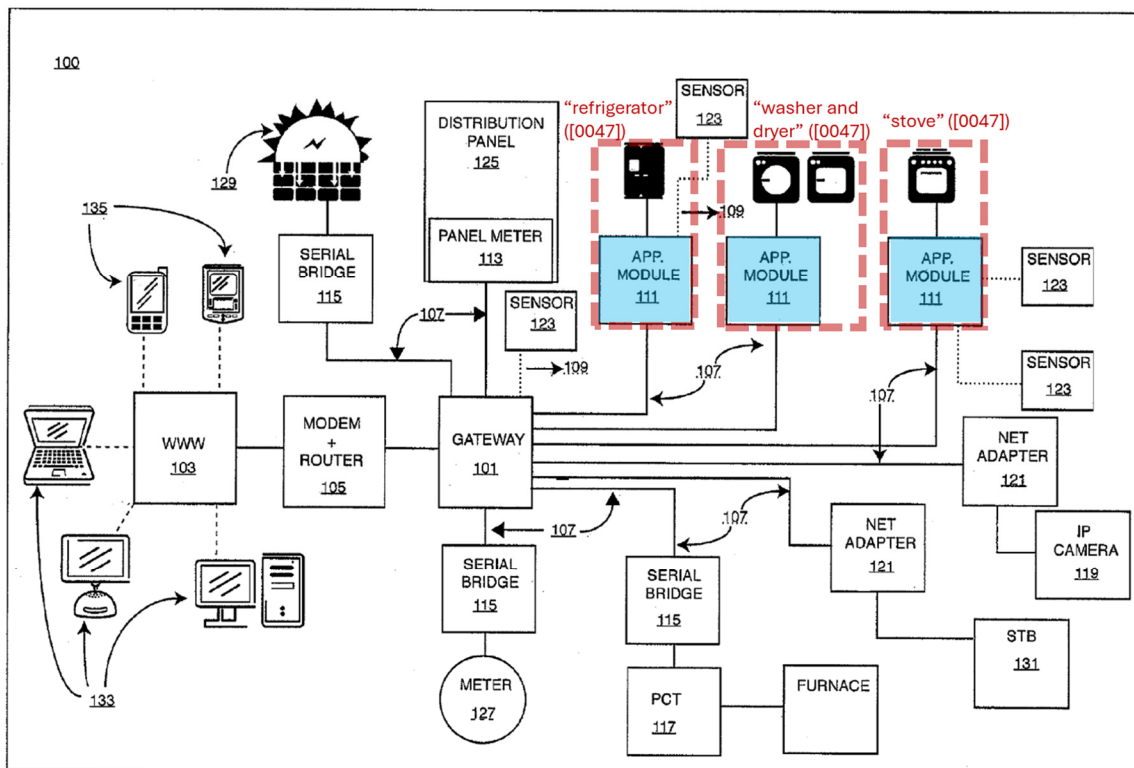


FIG. 1

139. Thus, the appliance module collects measurement data (*e.g.*, current, temperature, or other sensed parameters) from a connected appliance and transmits that data over the ZigBee wireless network to the gateway and other devices on the system 100 network.

140. Third, Chan discloses that the *wireless transceiver transmits digital data in response to* the physical phenomenon. An example *first sensor* is “*CT 425b* [that] measures current leakage on the neutral wire.” (EX1004, [0070].) Thus, the physical phenomenon is electrical current. Chan’s *appliance module* transmits digital data in response to electrical current (“physical phenomenon”). “Data measured by *appliance module 400* . . . includes power usage information.” (EX1004, [0075]; [0047].) “*Appliance module 400 sends* such data to gateway 300 via network infrastructure.” (EX1004, [0075], [0073].) A POSITA would have understood (and found it obvious) the appliance module transmits the “power usage information” in response to the electrical current measured by *current transformer 425b*. (EX1020, 10.)

141. Chan has other *first sensors* (*e.g.*, “temperature and humidity sensor 409,” “a motion sensor,” etc.). (EX1004, [0070], Claims 3-16.) Chan’s *appliance module* transmits digital data in response to the physical phenomena corresponding to these *first sensors*. Indeed, the “gateway 101 may be adapted to collect, aggregate, store, receive and or transmit information” and “may receive various

data signals containing data from the network or client devices.” (EX1004, [0046], [0063].) And it was well-known that such environmental information can be transmitted for appliance monitoring and control. (*E.g.*, EX1005, [0012]-[0017], [0049], [0051], [0081], [0083], [0099], [0106], [0015], [0120], [0126]; EX1045, 1:1-12, 4:4-16, 8:18-23, 11:19-12:2.) Thus, a POSITA would have understood (and found it obvious) that the *appliance module* likewise transmits digital data corresponding to other physical phenomena over the wireless network to the gateway for more comprehensive appliance monitoring and control.

142. To the extent that the claim requires the detection of physical phenomenon to trigger the data transmission (which is not conceded), it would have been obvious to a POSITA that Chan discloses or at least suggests this. For example, Chan states “*appliance module* [] may also be used for determining or locating client devices responsible for ‘vampire’ current and how much such leaks cost.” (EX1004, [0070], [0075].) Thus, it would have been obvious that, for example, upon detection of leakage current (*e.g.*, over a threshold) by *current transformer 425b*, digital data is transmitted to the gateway, thereby enabling real-time reporting and remediation of the leakage. For example, transmitting digital data in response to the sensed physical event enables real-time reporting of power consumption or leakage conditions (*e.g.*, “vampire” current) and automated system responses such as alerts or automatic appliance shutdown.

143. Likewise, it would have been obvious to a POSITA that digital data (*e.g.*, temperature data, humidity data, motion data, etc.) would be transmitted as a result of the corresponding physical phenomenon (*e.g.*, detection of temperature, detection of humidity, detection of motion, or detection of such phenomena exceeding a defined threshold, etc.). Such transmission would allow the *appliance module* to promptly communicate digital data indicative of the detected environmental condition to the gateway for monitoring or control. For example, transmitting digital data in response to a sensed change in temperature, humidity, or motion would enable quick reporting of environmental conditions and support automated system responses such as alert notifications or automatic appliance shutoff.

144. The data transmission is over the wireless network (*i.e.*, between the appliance module and the gateway). It would have been obvious that the appliance module transmits the data using its “Zigbee wireless chipset 405” (comprising a wireless transceiver). (EX1004, [0070].)

145. Chan further discloses that the *appliance module 400* converts measured current into *digital data* and transmits it to the gateway through the ZigBee wireless network. As shown in FIG. 4, the powerline module 403 “includes ... an analog to digital interface 435.” (EX1004, [0070].) A POSITA would have understood (and found it obvious) that the analog current signals

produced by *current transformer 425b* are converted to digital form by this *analog-to-digital interface 435* and processed by the *CPU 401*. The *CPU 401* communicates with *the ZigBee wireless chipset 405* (including the *wireless transceiver*) through an *RS-232 serial interface 407*. (EX1004, [0070].) RS-232 serial interfaces are digital communication links, which confirms that the data exchanged between *the CPU 401* and *ZigBee chipset 405* (including the *wireless transceiver*) is digital.

146. Accordingly, a POSITA would understand that the *current transformer 425b* is *coupled* (*i.e.*, through the analog-to-digital interface 435, CPU 401, and RS-232 (or other digital communication protocol) interface 407) to the ZigBee wireless (or other wireless communication protocol) chipset 405 (including the *wireless transceiver*) for transmitting digital data in response to the physical phenomenon (leakage current) to the wireless network.

j. 1[H]: “wherein the appliance is controlled or activated in response to digital data received from the wireless network, and;”

147. Chan discloses the appliance is *controlled or activated* in response to digital data received from the wireless network.

148. First, Chan discloses that the *appliance module* receives digital data from a wireless network. Chan describes “a networking infrastructure for energy monitoring and control systems used for monitoring, *controlling*, and transmitting

information via AC wiring or *wirelessly*, such as via the HomePlug™ or ZigBee™ standards, among others.” (EX1004, [0004].) For example, an *appliance module* “may be adapted to *receive* and transmit information across network infrastructure. (EX1004, [0047].)

149. As shown in FIG. 4, the *appliance module 400* includes “a Central Processing Unit (CPU) 401 that is connected to a powerline chipset 403 and a *ZigBee wireless chipset 405* through a RS-232 serial interface 407.” (EX1004, [0070].) The RS-232 interface is a digital communication link, confirming that the ZigBee chipset 405 both transmits and receives digital data over the wireless network and exchanges that data with the CPU 401. Chan further explains that “other signal media may be used by *appliance module 400* in communicating past the premises wiring system such as other wireless technologies, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0073].) In other words, the *appliance module 400* receives digital data wirelessly through its ZigBee wireless chipset 405, which includes *appliance module 400*’s *wireless transceiver*.

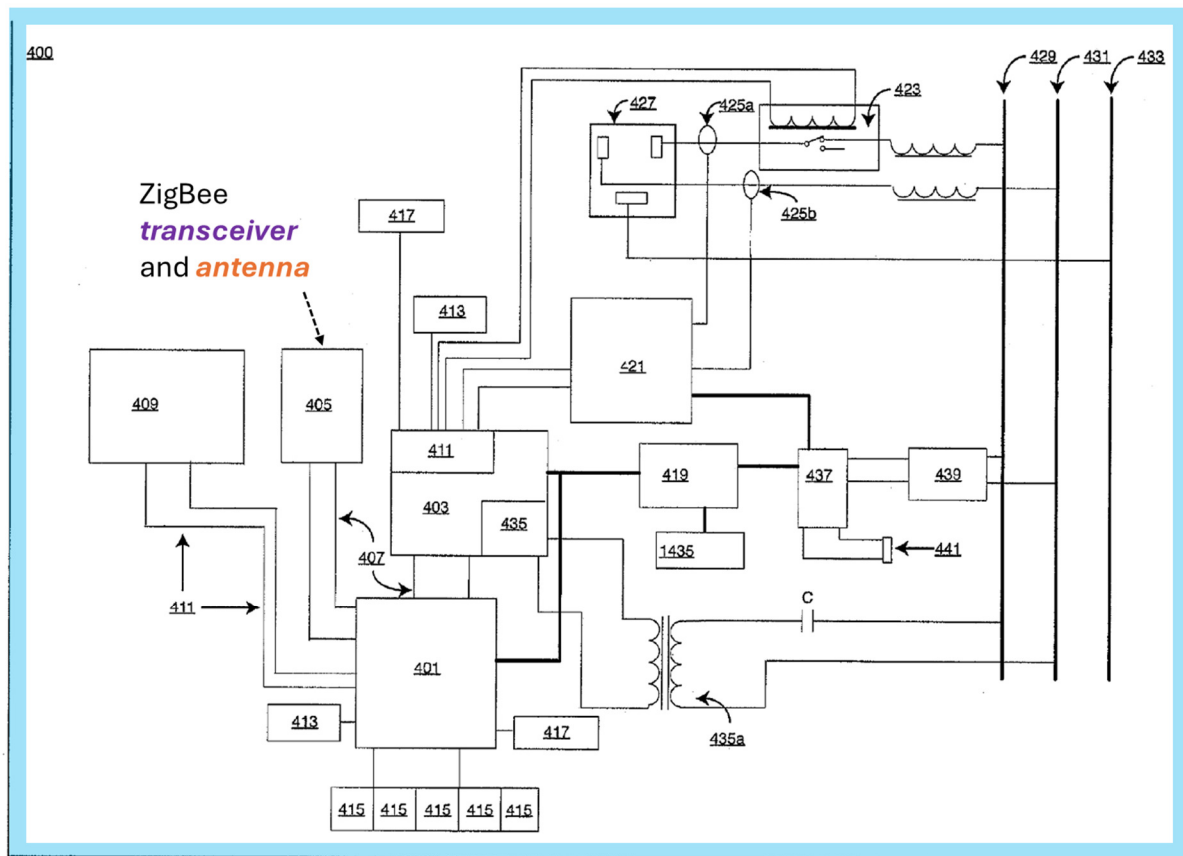


FIG. 4

150. Second, Chan discloses that the *appliance module* controls or activates the *appliance*. As shown in FIG. 1, system 100 includes “an *appliance module 111* [that] can connect to a variety of *appliances and devices such as refrigerator, washer and dryer, range, stove, microwave*, personal computer, television, or other appliance,” and that “an *appliance module 111* may be adapted to measure, store and/or *control* energy usage of connected appliances or devices, bridge ZigBee wireless sensors and devices to the network, or receive and transmit information across network infrastructure.” (EX1004, [0047].)

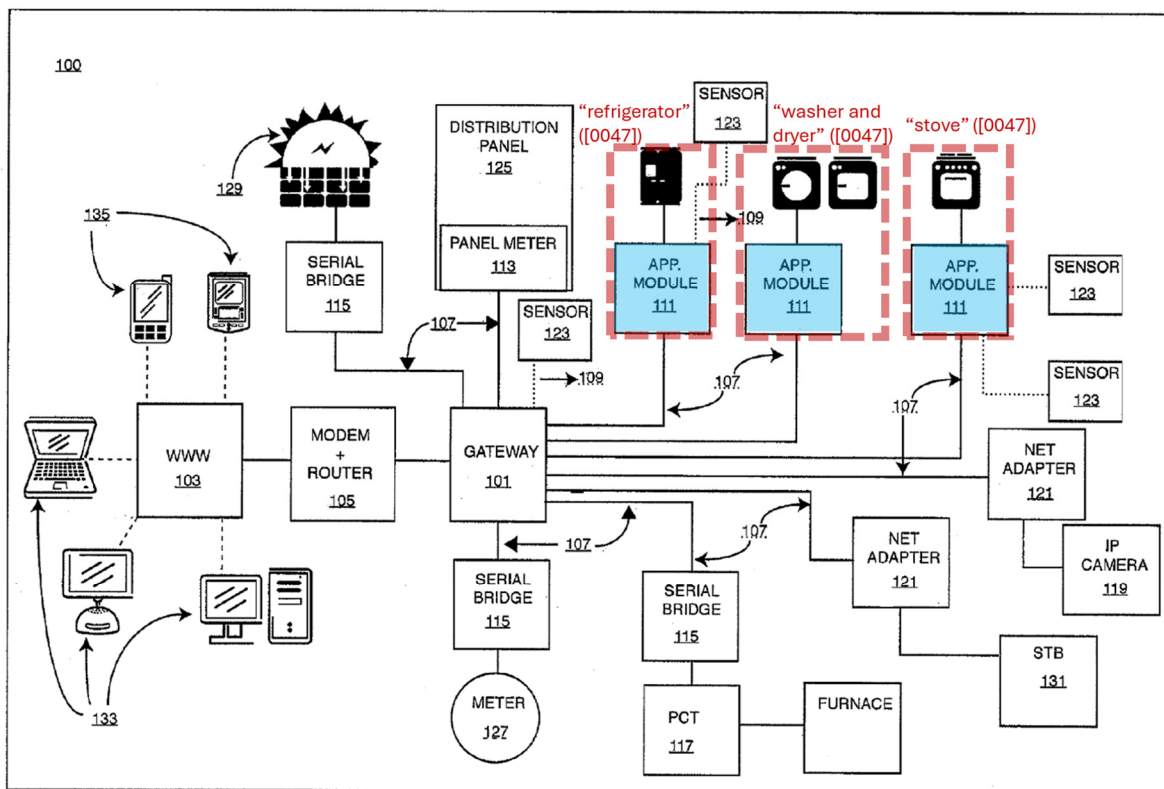


FIG. 1

151. Chan further describes that the system includes “an *appliance module configured to turn on or turn off one or more appliances*, which are coupled to the control module using either or both of *wireless module* or the control module.” (EX1004, [0009]; *see also id.*, [0047].) In this manner, Chan’s system 100 “provides the network infrastructure configured to connect various appliances or client devices to the World Wide Web and *allow remote command or control* of such devices.” (EX1004, [0010].) For example, “remote or local computing devices may connect to gateway 300 via the WorldWideWeb, internet or via the network infrastructure. A computer or mobile device running client software

applications may communicate with gateway 300 and send and receive data to client devices connected to the network infra structure via gateway 300.”

(EX1004, [0066].) In this manner, “Gateway 300 and the client devices connected to the network infrastructure may be monitored or controlled from anywhere in the world by a remote computing device. For example, a remote computing device may connect to gateway 300 via the internet and select a specific client device for adjustment of power usage or energy consumption. Additionally, remote computing devices may collect information or data stored on gateway 300 for processing or display on the graphical interface of the computing device.” (EX1004, [0066].)

152. FIG. 4 reinforces that functionality, disclosing that “[c]ommand or control of client devices may be provided by *appliance module 400*.” (EX1004, [0076]; *see also id.*, [0057], [0065].) For example, “*basic on or off switching of client devices* may be supported by *appliance module 400*.” (EX1004, [0076]; *see also id.*, [0057], [0065].) Thus, *appliance module 400* sends control or activation signals (such as on/off commands) to appliances.

153. Third, Chan discloses that these control operations occur in response to digital data received from the network formed between the gateway and the *appliance module*. Chan teaches that “some client devices may be specifically designed for coupling to *appliance module 400* for *command or control* by

gateway 300.” (EX1004, [0074].) Chan explains that “basic command or control signals ... may be low-bandwidth data signals” or “a high-bandwidth data signal to client devices in order to *provide a variety of command or control functionality*.” (EX1004, [0076]; *see also id.*, [0057], [0065].) For example, “a low-bandwidth signal may carry command or control information *from* gateway 300 *to appliance module 111* and *turn the connected appliance on or off*.” (EX1004, [0057].) In other words, the *wireless transceiver* of the *appliance module* receives data from the wireless network for controlling the *appliance*. These passages explain that digital command data is transmitted from the gateway to the *appliance module*, and the *appliance module* uses that information to carry out control actions in response.

154. FIG. 11 shows “a simplified software block diagram 1100 for the appliance module.” (EX1004, [0109].) Chan explains that the *appliance module* includes software that “control[s] the provisioning of high, low, or other bandwidth signals to client devices via appliance module coupling.” (EX1004, [0113].) In this manner, “[c]ommand or control of client devices coupled to appliance module may be carried out by appliance module software.” (*Id.*) As shown in FIG. 11, the appliance module 1100 includes a ZigBee driver 1117 in a driver layer 1103, and a command and control module 1127 and a data and command communication module 1129 in an application layer 1105. (EX1004, [0109].) Thus, the appliance

module's software receives digital command data from the ZigBee wireless network through driver 1117 (or other wireless protocols), processes it (e.g., through the command and control module 1127), and executes control actions for the connected appliance in response.

1100

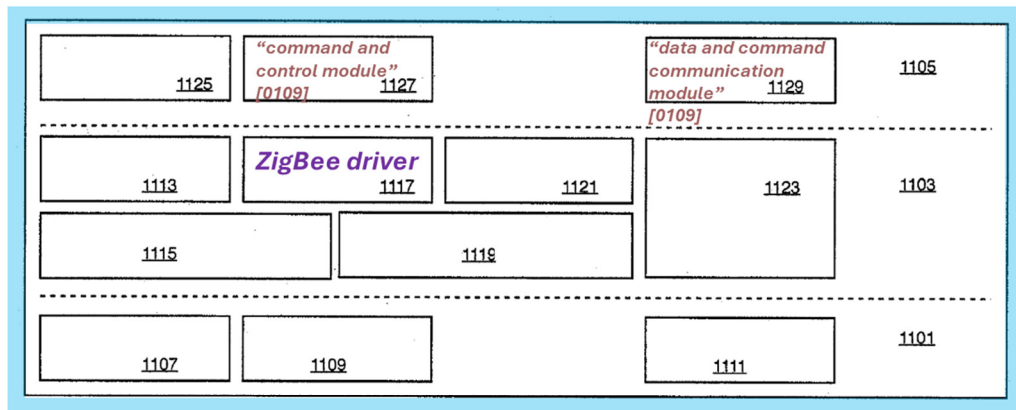


FIG. 11

155. A POSITA would have understood that Chan's *appliance module* thus receives digital data from the wireless network (e.g., using the ZigBee wireless chipset 405 or other wireless protocol chipsets and RS-232 interface 407 (or other digital communication interfaces)), processes that data using the CPU 401 and software architecture shown in FIG. 11, and uses it to *control or activate* the

appliance. Indeed, Chan discloses “an *appliance module* coupled to the gateway apparatus, the *appliance module* being *configured to turn on or turn off one* or more appliances, the *appliance module* being coupled to the control module using either or *both of wireless module* or the control module.” (EX1004, Claim 1.)

Accordingly, Chan teaches that the appliance is controlled or activated in response to digital data received from the wireless network.

k. 1[I]: “wherein the current sensor is further coupled to the wireless transceiver for transmitting digital data in response to the measured AC current to the wireless network.”

156. Chan discloses that the *current sensor* is further *coupled to* the *wireless transceiver* for transmitting digital data in response to the *measured AC current* to the wireless network.

157. First, Chan shows in FIG. 4 that the current sensor *is coupled* to the *wireless transceiver*. (EX1004, [0070].) FIG. 4 illustrates that the appliance module 400 includes “a Central Processing Unit (CPU) 401 that *is connected to a* powerline chipset 403 and *a ZigBee wireless chipset 405 through a RS-232 serial interface 407*,” and “a power-measure module 421 [that] *is connected to* a power supply 437 and two (2) *current transformers (CTs) 425a* and 425b that are connected to a *standard AC socket 427*.” (EX1004, [0070].)

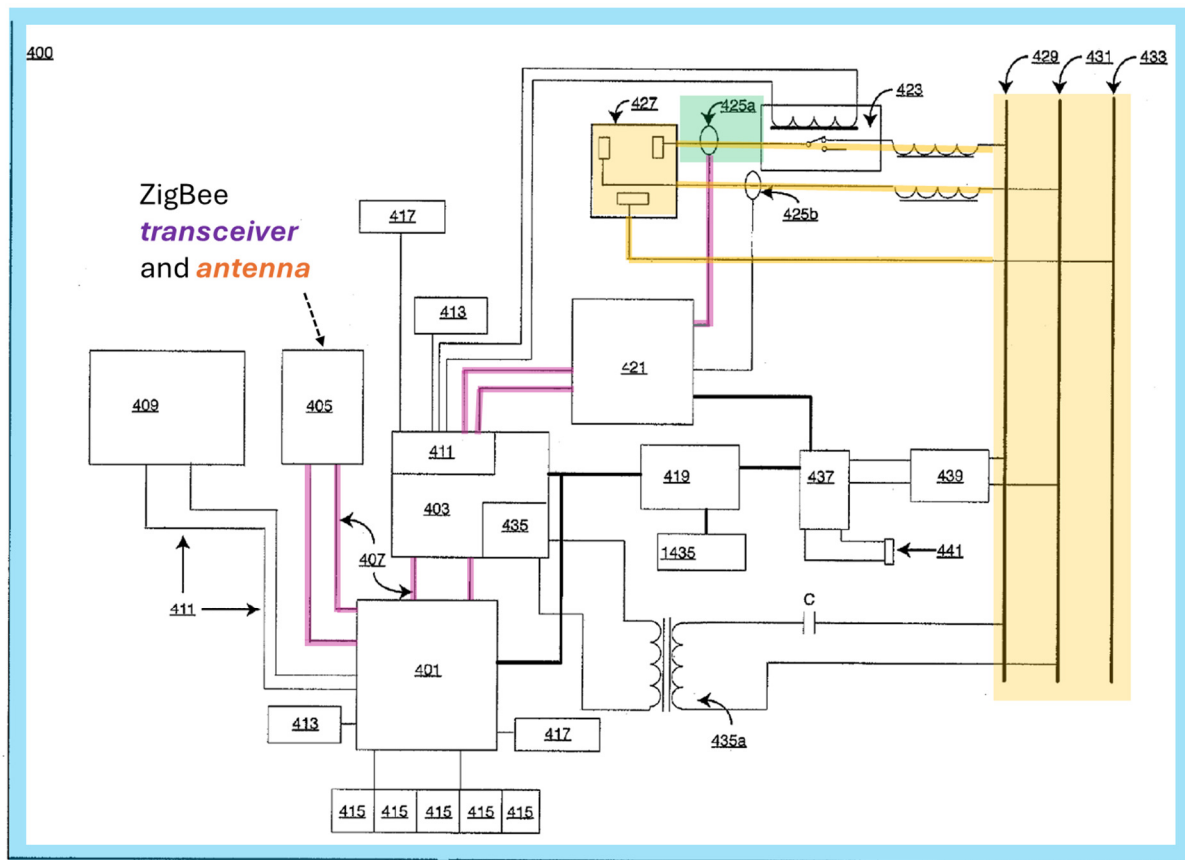


FIG. 4

158. As shown in FIG. 4, “one CT 425a measures current on the live wire 429.” (EX1004, [0070].) A POSITA would understand that current transformer 425a (i.e., the current sensor) is coupled to the CPU 401 through the power-measure module 421 and powerline chipset 403, and that the CPU 401 is coupled to the ZigBee wireless chipset 405 via the RS-232 serial interface 407. (Id.) Accordingly, current transformer 425a is coupled (through these intermediary components) to the ZigBee wireless chipset 405, which includes the wireless transceiver of appliance module 400. Such intermediary coupling between the current sensor and the wireless transceiver is consistent with the coupling in the

'590 patent, which shows a computer coupled in between *ampermeter 57a* and *modem 54*. (EX1001, FIG. 5e.)

159. Second, Chan discloses that the *appliance module* transmits measurement data over a network infrastructure utilizing wireless communication paths. As discussed above, such *network infrastructure* encompasses a wireless infrastructure. (*Supra*, § IX.A.2.c.) Chan explains that the system includes *appliance modules* that “may send and receive data across the integrated network in relation to a particular appliance.” (EX1004, Abstract.) As shown in FIG. 1, system 100 includes “an *appliance module 111* [which] can connect to a variety of *appliances* and devices such as *refrigerator, washer and dryer, range, stove, microwave*, personal computer, television, or other appliance,” and that “an appliance module 111 may be adapted to *measure*, store and/or control *energy usage* of connected appliances or devices, bridge ZigBee wireless sensors and devices to the network, or *receive and transmit* information *across network infrastructure*.” (EX1004, [0047].) A POSITA would understand from these disclosures that the *appliance module* measures energy data (*e.g.*, current data) from a connected appliance *and transmits that data over network infrastructure* to the gateway or other devices on the system 100 network, and it would have been obvious to do so. As discussed above, such network infrastructure encompasses a wireless infrastructure. (*Supra*, § IX.A.2.c.)

160. It also would have been obvious to a POSITA to implement such wireless transmission of current data between *gateway 101* and the *appliance modules 111*. Both components already include wireless communication hardware (e.g., chipsets to support ZigBee, Wi-Fi, Bluetooth, or other wireless technologies). (EX1004, [0070], [0073].) Wireless communication was well-known and routinely used in home automation and energy monitoring systems at the time of the invention to simplify setup and improve user convenience. (See e.g., EX1005, EX1051.) Accordingly, it would have been an obvious and predictable design choice for a POSITA to implement a wireless connection between Chan's gateway and *appliance modules* to achieve these well-understood advantages.

discloses that “the powerline data signal ... may be further transmitted by appliance module 400 as a wireless RF signal.” (EX1004, [0073].) A POSITA would recognize that this “power-usage information” includes data derived from the current measured by *current transformer 425a*, since that current transformer provides the current measurements used to calculate power consumption. (EX1020, 10 (“Power=V [voltage] x I [current]” and “Power = I²R[resistance]”).)

162. Fourth, Chan’s disclosure also demonstrates that the digital data transmitted by the *appliance module* is *in response to* the measured AC current. For the same reasons discussed for CT 425b, a POSITA would have understood (and found it obvious) the appliance module transmits the “power usage information” in response to the electrical current measured by *CT 425a* to the wireless network for quick reporting and response. (*Supra* § IX.A.2.i; EX1020, 10.) For example, “[d]ata measured by *appliance module 400* as a preferred embodiment includes power usage information...*Appliance module 400* sends such data to gateway 300 via *network infrastructure*.” (EX1004), [0075].) As discussed, the *network infrastructure* is *wireless*. (*Supra* IV.A.2.c.) Indeed, “[d]ata provided by *appliance module 400* may be used [by remote computing devices connected to the gateway] for determining energy footprint, energy efficiency, sources of energy waste, levels of consumption, energy cost, or carbon footprint.” (EX1004, [0066], [0070], [0075]).

163. Third, Chan further discloses that the *appliance module 400* converts the measured current into *digital data* and transmits it to the gateway through the ZigBee wireless network. As shown in FIG. 4, the powerline module 403 “includes ... an analog-to-digital interface 435.” (EX1004, [0070].) A POSITA would understand that the analog current signals produced by *current transformer 425a* are converted to digital form by this analog-to-digital interface 435 and processed by the CPU 401 before being sent through the RS-232 serial interface 407 to the ZigBee wireless chipset 405. Because RS-232 interfaces transmit digital data, a POSITA would recognize that the information exchanged between the CPU 401 and ZigBee chipset 405 (including current-measurement data) is digital.

164. Based on these disclosures, a POSITA would understand that *current transformer 425a* (i.e., the “*current sensor*”) *is coupled* (through the analog-to-digital interface 435, CPU 401, and RS-232 (or other digital communication protocol) interface 407) to the ZigBee wireless (or other wireless protocol) chipset 405 (including the *wireless transceiver*) for transmitting digital data generated *in response to* the measured AC current to the wireless network. This is consistent with Chan’s own description that the appliance module “may send and receive data across the integrated network in relation to a particular appliance.” (EX1004, Abstract.)

3. Claim 2: “The appliance according to claim 1, wherein the primary function of the appliance is heating food.”

165. Chan teaches the primary function of the *appliance* is heating food.

For example, as seen in FIG. 1, “*appliance module[s] 111* can connect to a variety of appliances and devices such as refrigerator, washer and dryer, *range, stove, microwave*, personal computer, television, or other appliance.” (EX1004, [0047]; *see also id.*, [0009], [0071].) *Ranges, stoves, and microwaves* are appliances with a primary function of heating food. Thus, Chan’s appliance, which is a range, stove, or microwave, has a primary function of heating food.

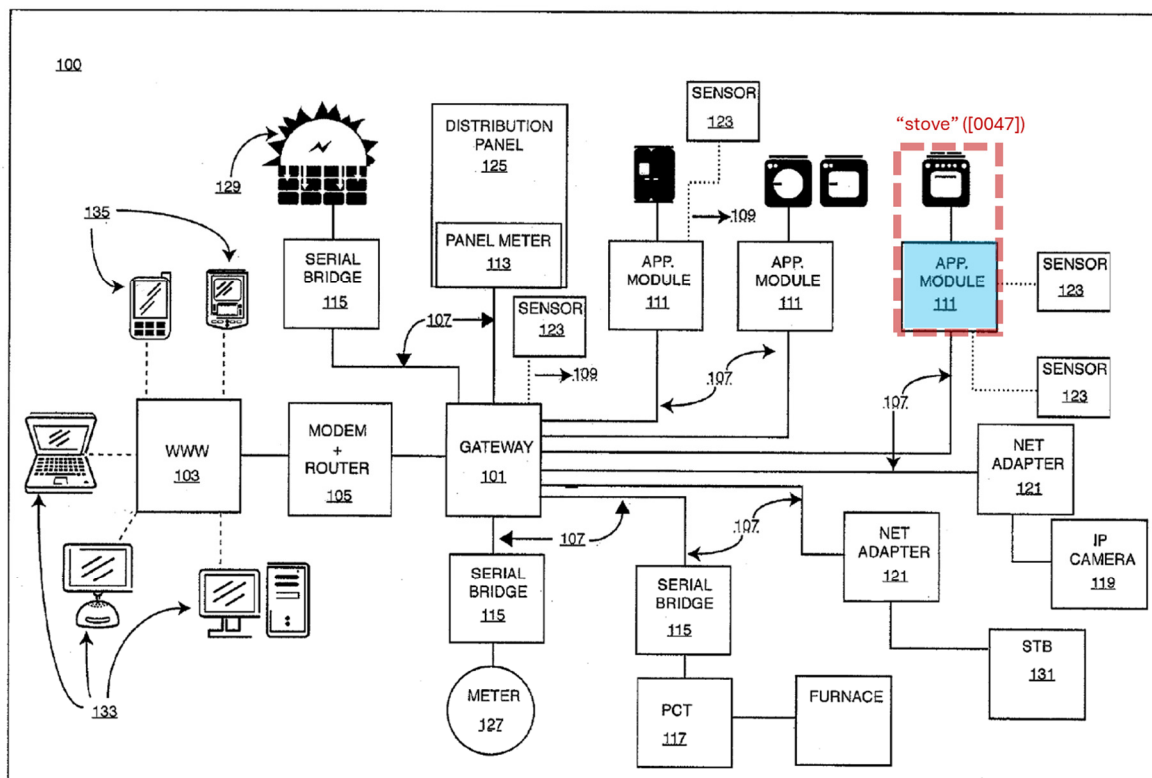


FIG. 1

4. Claim 3: “The appliance according to claim 2, wherein the appliance comprises a microwave oven, an electric mixer, a stove, an oven, or an induction cooker.”

166. Chan teaches the appliance comprises a *microwave oven*, an electric mixer, *a stove, an oven*, or an induction cooker. For example, as seen in FIG. 1, “*appliance module[s] 111* can connect to a variety of appliances and devices such as refrigerator, washer and dryer, *range, stove, microwave*, personal computer, television, or other appliance.” (EX1004, [0047]; *see also id.*, [0009], [0071].)

5. Claim 4: “The appliance according to claim 1, wherein the primary function of the appliance is cooling food.”

167. Chan teaches the primary function of the *appliance* is cooling food. For example, as seen in FIG. 1, “*appliance module[s] 111* can connect to a variety of appliances and devices such as *refrigerator*, washer and dryer, range, stove, microwave, personal computer, television, or other appliance.” (EX1004, [0047]; *see also id.*, [0009], [0071].) A *refrigerator* is an appliance with a primary function of cooling food.

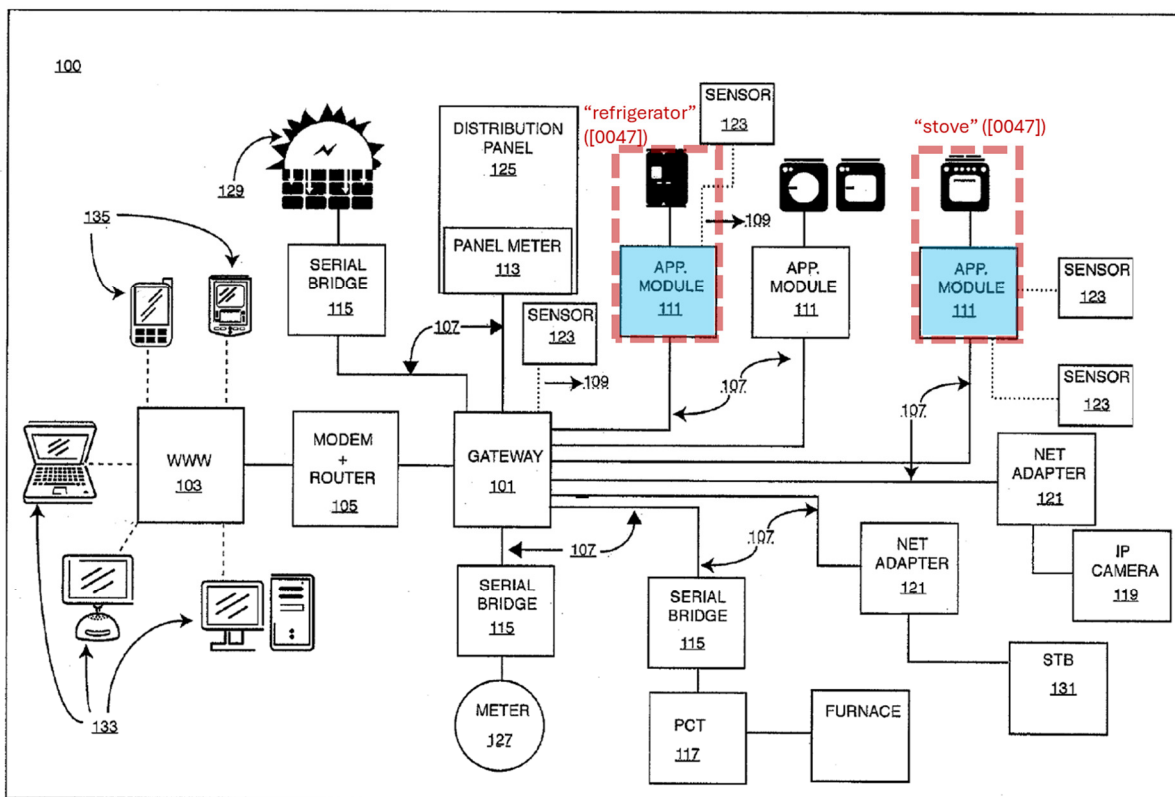


FIG. 1

6. Claim 5: “The appliance according to claim 4, wherein the appliance comprises a refrigerator, a freezer, or an iced-tea maker.”

168. Chan teaches the primary function of the *appliance* is cooling food. For example, as seen in FIG. 1, “*appliance module[s] 111* can connect to a variety of appliances and devices such as *refrigerator*, washer and dryer, range, stove, microwave, personal computer, television, or other appliance.” (EX1004, [0047]; *see also id.*, [0009], [0071].)

7. Claim 6: “The appliance according to claim 1, wherein the appliance comprises a dishwasher, a food blender, a beverage maker, or a coffeemaker.”

169. Chan discloses its “*appliance module[s]* 111 can connect to *a variety of appliances and devices* such as *refrigerator*, washer and dryer, *range, stove, microwave*, personal computer, television, or other appliance.” (EX1004, [0047]; *see also id.*, [0009], [0071].)

170. It would have been obvious to a POSITA that the variety of appliances also includes a dishwasher. For example, it would have been obvious that Chan’s *appliance module* could be connected to a dishwasher for energy monitoring. It was well-known that energy monitoring of dishwashers was useful since dishwashers are large kitchen appliances that consume energy. For example, Botts discloses that an energy usage monitor may be placed in household appliances such as “an oven or wall oven, a range, a cooktop, a microwave, a *dishwasher*, a washing machine, a dryer, an exhaust fan or vent, a heated or cooled built-in drawer, such as a drawer configured to dry and store dishes, eating utensils, and cooking utensils such as pots and pans.” (EX1006, 4:20-25.)

8. Claim 7: “The appliance according to claim 1, further comprising in the single enclosure an electrically actuated switch connected to a switch electric power to at least part of the appliance, wherein the electrically actuated switch is coupled to the wireless transceiver for being activated in response to digital data received from the wireless network.”

171. Chan teaches an *electrically actuated switch* in the *single enclosure* connected to switch electric power to at least part of the appliance, wherein the

electrically actuated switch is coupled to the *wireless transceiver* for being activated in response to digital data received from the wireless network.

172. First, Chan teaches the single enclosure formed by the *appliance module* houses an *electrically actuated switch*. As shown below in FIG. 4, *appliance module 400* includes “a *relay switch 423*.” A POSITA would understand such a relay switch to be an electrically actuated switch. (EX1007, 307 (“Relays are electrically actuated switches.”))

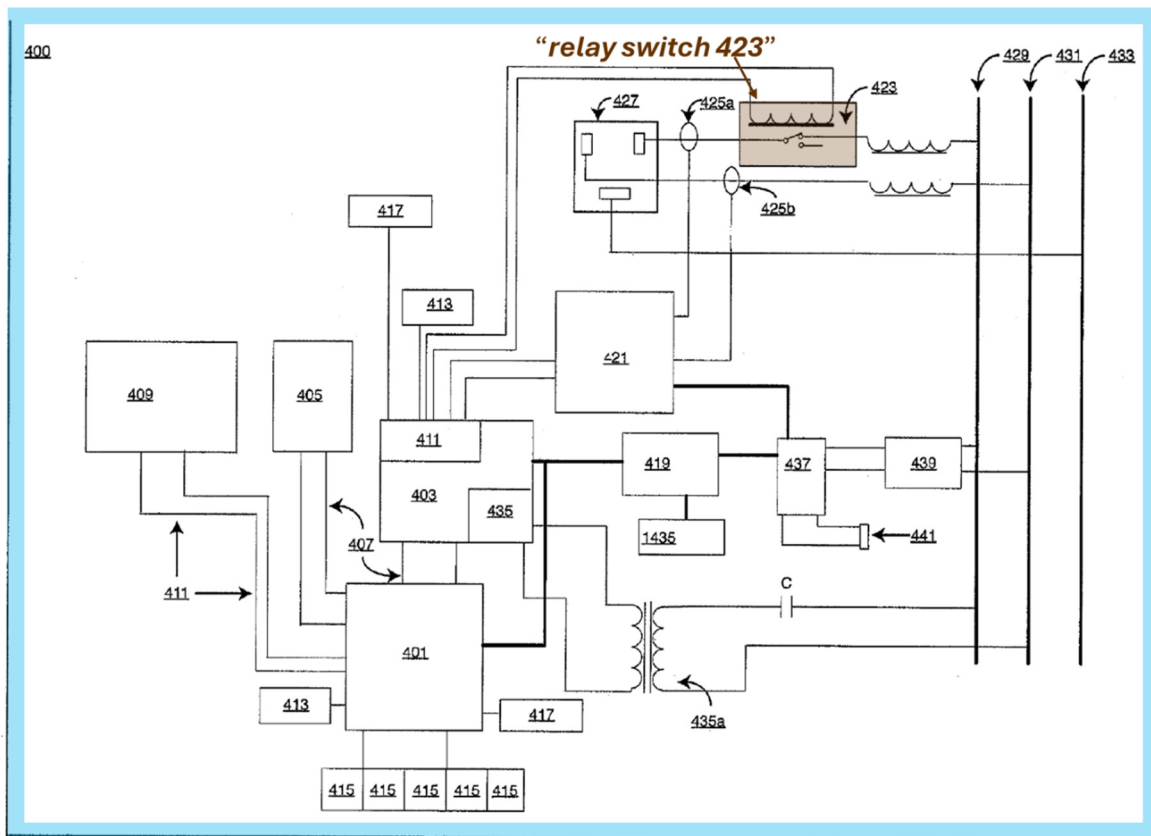
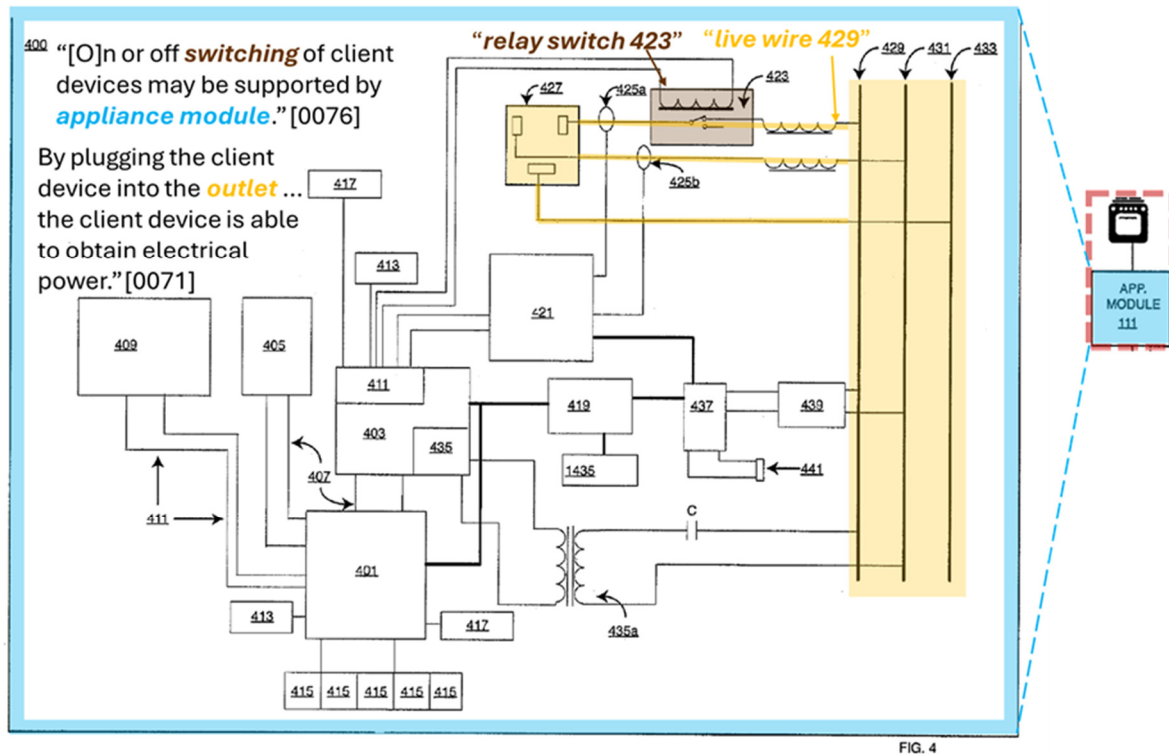


FIG. 4

173. Second, Chan teaches the electrically actuated relay switch is connected to switch electric power to at least part of the appliance. For example,

as shown in FIG. 4, the *relay switch 423* is coupled in between *AC socket 427* and the *live wire 429*. (EX1004, [0070], FIG. 4.) Thus, the POSITA would understand that *relay switch 423* operates to allow or stop current from flowing from the *live wire 429* to *AC socket 427*. As described previously, the appliance receives power by plugging into *AC socket 427* of the *appliance module 400*. Thus, a *relay switch* that operates to allow or stop current from flowing from the *live wire 429* to *AC socket 427* (which supplies power to the appliance), is a *switch* connected to switch electric power to at least part of the appliance. This is consistent with Chan's disclosure that "[b]asic on or off switching of client devices may be supported by *appliance module 400*." (EX1004, [0076].) In other words, a POSITA would have understood (and found it obvious) that *relay switch 423* supports "[b]asic on or off switching of client devices" plugged into *AC socket 427*. (EX1004, [0070], [0076], FIG. 4.)



174. Third, Chan’s FIG. 4 shows the **coupling** of **relay switch 423** to the **wireless transceiver** for being activated in response to digital data received from the wireless network. For example, FIG. 4 shows “a Central Processing Unit (CPU) 401 that is **connected to** a powerline chipset 403 and a Zigbee wireless chipset 405 **through a RS232 serial interface**.” (EX1004, [0070].) The powerline module 403 includes “a plurality of I/O ports 411,” and “[e]ach I/O port 411 **is connected** to a variety of sources” including “**relay switch 423**.” (EX1004, [0070].)

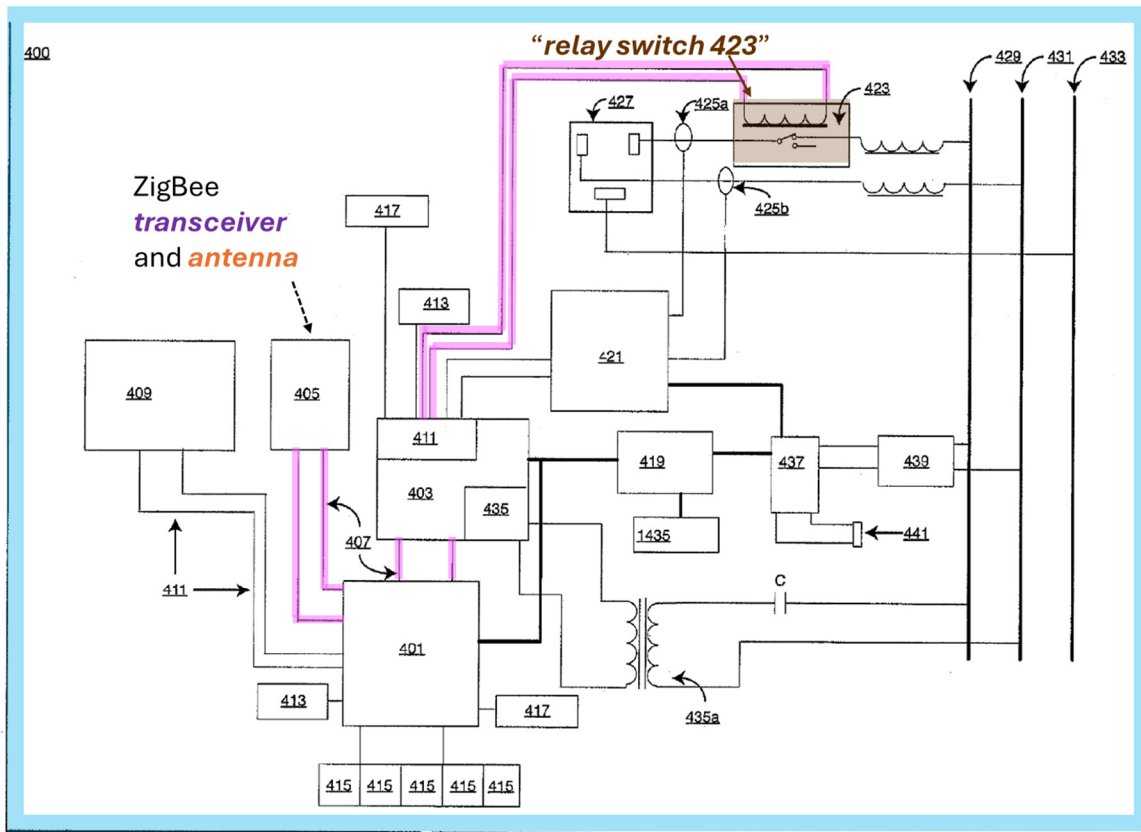


FIG. 4

175. A POSITA would understand that **relay switch 423** is **coupled** to the CPU 401 **through** the power-measure module 421 and powerline chipset 403, and that the CPU 401 **is coupled to** the ZigBee wireless chipset 405 **via the RS-232 serial interface 407**. (EX1004, [0070].) Accordingly, **relay switch 423 is coupled** (through these intermediary components) to the ZigBee wireless chipset 405, which includes the **wireless transceiver** of **appliance module 400**.

176. Fourth, Chan teaches the **switch** is activated in response to digital data received from the wireless network. As described above, the **relay switch 423** of **appliance module 400** is used for “[b]asic on or off switching of client devices.”

(EX1004, [0076].) The appliance module performs this function in response to “basic command or control signals ... [which] may be low-bandwidth data signals” or “a high-bandwidth data signal to client devices in order to *provide a variety of command or control functionality*.” (EX1004, [0076]; *see also id.*, [0057], [0065].) For example, “a low-bandwidth signal may carry command or control information *from* gateway 300 *to* *appliance module 111* and *turn the connected appliance on or off*.” (EX1004, [0057].) Such signals are transmitted using “wireless signal technology.” (*Id.*) Thus, the *relay switch 423* of *appliance module 400* is activated by signals carrying command information received from a wireless network.

177. The POSITA would also recognize that the data received by ZigBee chipset 405 is digital. Chan specifies that the CPU communicates with the ZigBee wireless chipset through an RS-232 serial interface 407. (EX1004, [0070].) RS-232 serial interfaces transmit binary data in a bitwise fashion, confirming that the information sent to and from the ZigBee chipset 405 is digital. (EX1019, 1.) This is consistent with the ’590 patent’s own statement that “ZigBee is a specification for a suite of high-level communication protocols using small, low-power *digital radios* based on an IEEE 802 standard for personal area networks.” (EX1001, 4:3-16.)

9. Claim 13: “The appliance according to claim 1, wherein the current sensor comprises a current clamp, a current probe, a current transformer, or uses a ‘Hall effect’.”

178. Chan discloses its current sensor comprises a current clamp, a current probe, a *current transformer*, or uses a “Hall effect.” As discussed above, Chan discloses *a current sensor* coupled to the *AC connector* for measuring an AC current consumed by the appliance. (*Supra* § IX.A.2.e.) The *current sensor* is a *current transformer*. (EX1004, [0070]; *supra*, §IV.A.2.e.) For example, Chan discloses “[t]he power measure module 421 is connected to a power supply 437 and two (2) *current transformers (CT) 425a* and 425b that are connected to a standard AC socket 427.” (EX1004, [0070].) “*CT 425a* measures current on the live wire 429.” (*Id.*)

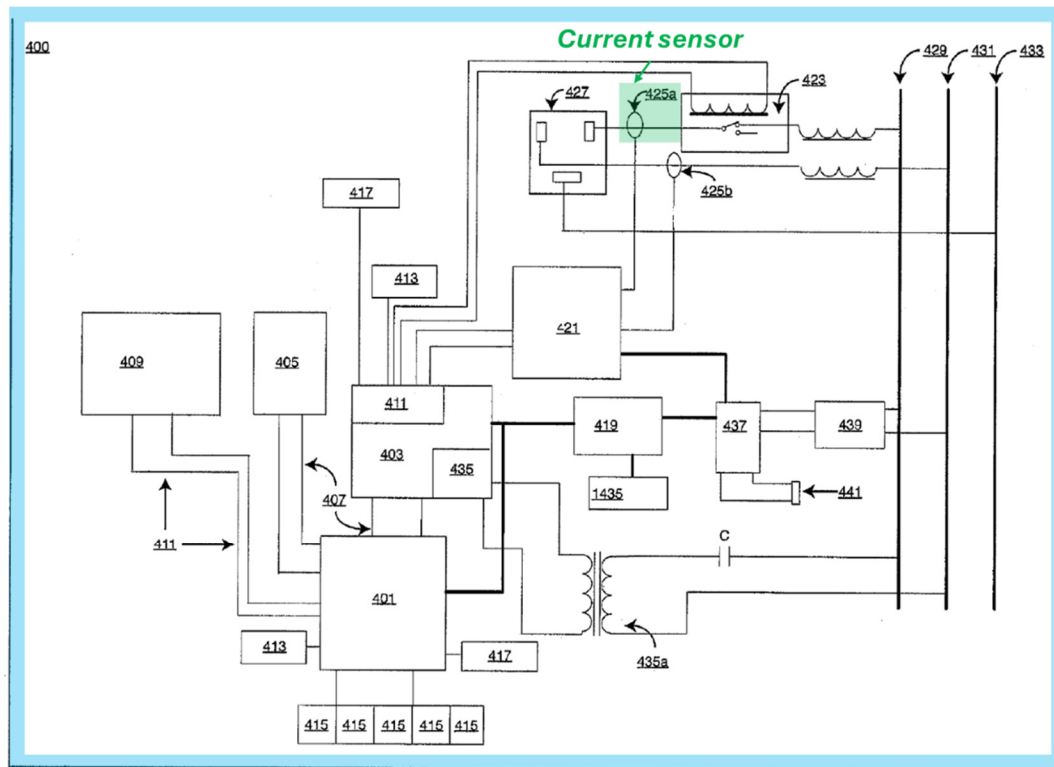


FIG. 4

10. Claim 14: “The appliance according to claim 1, wherein the current sensor is a non-contact or a non-conductive current meter.”

179. Chan discloses the current sensor is a non-contact current meter. For example, Chan's *current sensor* is a *current transformer*. (EX1004, [0070]; *supra*, §IV.A.2.e.) For example, Chan discloses “[t]he power measure module 421 is connected to a power supply 437 and two (2) *current transformers (CT) 425a* and 425b that are connected to a standard AC socket 427.” (EX1004, [0070].) “*CT 425a* measures current on the live wire 429.” (*Id.*) The *current transformer 425a* detects the AC current consumed by the connected appliance and provides input to the power measure module for determining energy usage.

180. In 2012, it was well-known that sensors measuring voltage or current came in two categories: “contacting and *contactless*.” (EX1008, 1.) Middelhoek, a textbook, provides an overview of contactless current sensors such as “electro-optical sensors and piezoelectric sensors” in Sections 1.1.7 and 1.1.8. Middelhoek discloses that “[t]hese sensors are *contactless*, they *do not require conductive connections* to either of the two points whose potential difference is to be sensed.” (EX1008, 3.) Further, it was well-known that “[t]he output from *contactless sensors* is galvanically isolated from the source of the signal. Usually contactless sensors affect the variable to be measured less.” (EX1008, 1.)

181. A POSITA would therefore have recognized that Chan’s *current transformer 425a* is a *contactless current sensor* operating by **electromagnetic induction**. It was well-known that *current transformers* are non-contact sensors because they operate by electromagnetic induction. Current transformers measure current through the magnetic field generated by a primary conductor, inducing a proportional voltage or current in a secondary winding without requiring a direct electrical connection. (EX1020, 56-58; EX1008, 59.) Sinclair explains that “the changing flux around a coil that carries a changing current will also *induce* a voltage in another coil. This is the principle of the *transformer* . . . A simple transformer, pictured in Figure 4.12(a), consists of two coils that are wound on a common magnetic core. When the current through one coil (the primary winding)

changes, *a voltage is induced* in the other winding (the secondary winding).” (EX1020, 56-58.) Middelhoek likewise describes that “a simple *inductive sensor* consists of a coil with one or more windings” and that “the voltage drop over the resistor is proportional to the alternating current.” (EX1008, 59.) Middelhoek further identifies a *current transformer* as an example of such an inductive sensor, in which “the current transformer on the secondary side is provided with a secondary winding consisting of two astatically designed coils laying next to one another.” (*Id.*) Based on these disclosures, a POSITA would have recognized (and found it obvious) that Chan’s *current transformer 425a* operates based on induction and is therefore a non-contact current meter, because it measures current through induced voltage rather than direct electrical contact.

11. Claim 15: “The appliance according to claim 1, further comprising in the single enclosure a wattmeter connected to the AC connector for measuring the magnitude of the active AC power or an electrical energy consumed by the appliance.”

182. Chan discloses a *wattmeter* in the *single enclosure* connected to the *AC connector* for measuring the magnitude of the active AC power or an electrical energy consumed by the appliance.

183. First, Chan discloses a *wattmeter* for measuring the magnitude of the active AC power. As shown in FIG. 4, the *appliance module* includes a “*power measure module 421*.” (EX1004, [0070].) “Data measured by *appliance module*

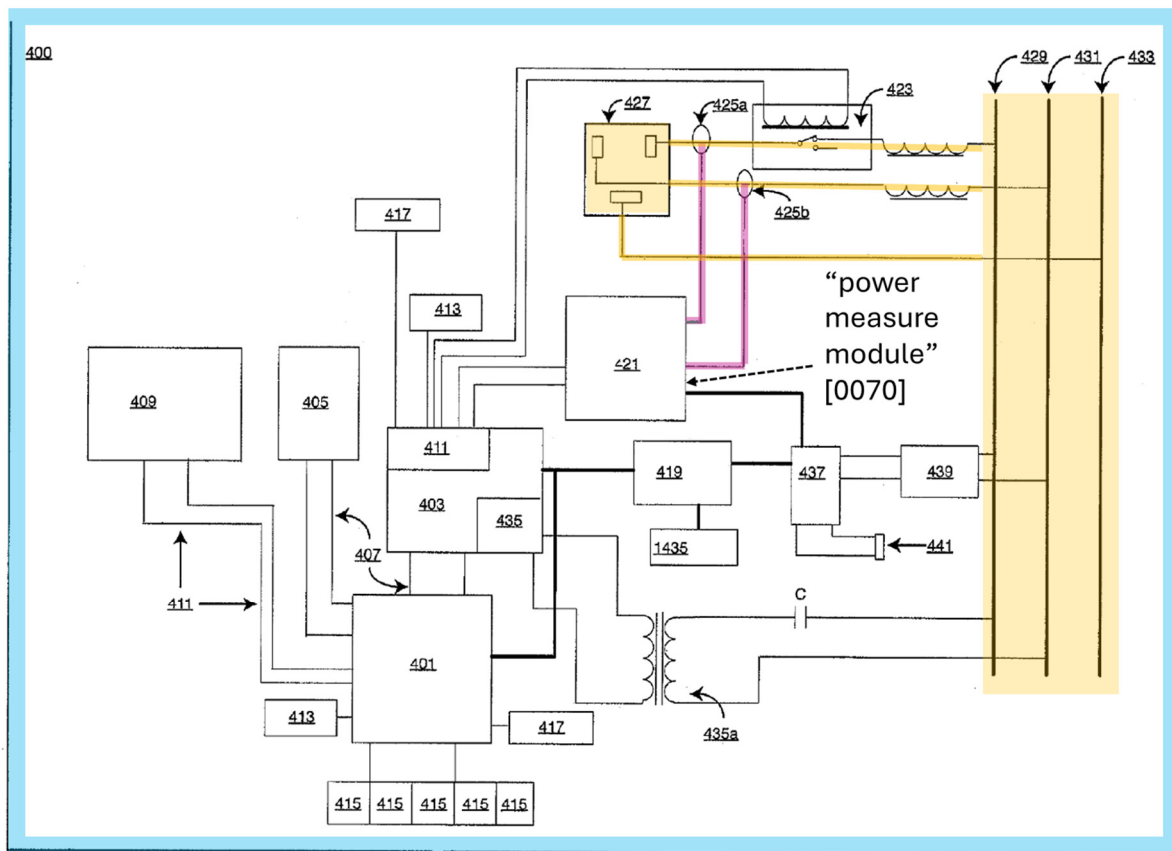
400 as a preferred embodiment includes power usage information, such as instantaneous power, peak power, or average power.” (*Id.*) A POSITA would understand that the **power measure module 421** is the component of the **appliance module 400** that takes such measurements. The POSITA would also understand that a **power measure module** configured to measure instantaneous, peak, or average power is a **wattmeter**, since a wattmeter is a device for measuring electrical power in watts. (*E.g.*, EX1001, 69: 39-42 (“a wattmeter measur[es] the magnitude of the active power (or the supply rate of electrical energy), commonly using watts (W), milliwatts, kilowatts, or megawatts units.”))

184. Second, Chan also discloses a system that includes “an **energy monitor unit** for each appliance load **that plugs into a standard AC wall outlet and monitors power consumption.**” (EX1004, [0008].) Further, “**appliance module 111** may be adapted to **measure, store and or control energy usage** of connected appliances or devices.” (EX1004, [0070], [0047].) A POSITA would have understood (and found it obvious) that energy is a function of power, and by measuring the **energy** consumed by the appliance, the **energy monitor unit** or **appliance module** measures the magnitude of the active AC power consumed by the appliance as well. (EX1020, 10-11.)

185. Third, Chan discloses that the power measure module 421 is enclosed in the **appliance module** (*i.e.*, “the **single enclosure**”). As discussed

above, Chan’s *appliance module 400* serves as the single enclosure that house all four claimed components (*e.g.*, current sensor, first sensor, wireless transceiver, and antenna) within a single housing.

186. Fourth, Chan’s *wattmeter* is connected to the **AC connector**. As shown in FIG. 4, Chan’s “*power measure module 421* is connected . . . to a **standard AC socket 427** . . . plugged directly onto the **AC wiring**.” (EX1004, [0070].) Further, Chan’s *energy monitor unit* is connected to the **AC connector** because the “*energy monitor unit* . . . plugs into a **standard AC wall outlet**.” (EX1004, [0008].)



12. Claim 16: “The appliance according to claim 15, wherein the wattmeter comprises a single or multi-phase AC power or energy meter.”

187. As discussed, Chan’s *appliance module* further comprises a *power measure module 421* (i.e., *wattmeter*). (*Supra* § IX.A.2.e11.)

188. Chan also discloses the *wattmeter* comprises a single or multi-phase AC power or energy meter. Chan explains that the *appliance module* is coupled between an appliance and a standard wall outlet and includes a power measure module 421 coupled to current transformer 425a for detecting current and energy usage. (EX1004, [0070]-[0071], FIG. 4.) In particular, a POSITA would have understood (and found it obvious) that power measure module 421 would operate with the *same phase configuration as the AC power source* to which the appliance module is connected. In typical residential applications, that source is a single-phase, 120-V, 60-Hz supply. As explained by Scherz, “In the United States, homes receive a 60-Hz, 120-V single-phase voltage, whereas industry typically receives a 60-Hz, 208-V/120-V three-phase voltage.” (EX1007, 901.) Thus, a POSITA would have understood (and found it obvious) that when appliance module 400 is used in a residential environment, power measure module 421 functions as a *single-phase AC wattmeter*. Conversely, when the same design is used in a commercial or industrial environment supplied by three-phase power, a POSITA would have recognized that the *power measure module 421* could readily

be implemented as a *multi-phase AC wattmeter*, with voltage and current sensors corresponding to each phase. Accordingly, a POSITA would have understood (and found it obvious) that Chan’s power measure module 421 could be configured for either *single-phase residential or multi-phase industrial* AC systems.

189. Further, Chan discloses that its system “couple[s] to a power source including a first phase, a second phase, and a third phase.” (EX1004, [0009].) It would have been obvious to a POSITA that the wattmeter would comprise a multi-phase AC power or energy meter.

13. Claim 19: “The appliance according to claim 15, wherein the wattmeter or the current sensor are induction based.”

190. As discussed, Chan’s *current sensor* is a *current transformer*. (*Supra* §IX.A.9.) For example, Chan discloses “[t]he power measure module 421 is connected to a power supply 437 and two (2) *current transformers (CT) 425a* and 425b that are connected to a standard AC socket 427.” (EX1004, [0070].)

191. A POSITA would have understood (and found it obvious) that *current transformers* are induction based. “The changing flux around a coil that carries a changing current will also *induce* a voltage in another coil. This is the *principle of the transformer* . . . A simple transformer, pictured in Figure 4.12(a), consists of two coils that are wound on a common magnetic core. When the current through one coil (the primary winding) changes, a voltage is *induced* in the other winding

(the secondary winding).” (EX1020, 56-58.) “A simple *inductive* sensor consists of a coil with one or more windings. Its both ends are connected through a measuring resistor. The voltage drop over the resistor is proportional to the alternating current.” (EX1008, 59.) An example of the inductive sensor is a current transformer where “the current transformer on the secondary side is provided with a secondary winding consisting of two astatically designed coils laying next to one another and connected in series.” (EX1008, 60.)

14. Claim 20: “The appliance according to claim 1, wherein the wireless network is a Wireless Personal Area Network (WPAN), the antenna is a WPAN antenna, and the wireless transceiver is a WPAN modem.”

192. Chan discloses its wireless network is a Wireless Personal Area Network (WPAN), the antenna is a WPAN antenna, and the wireless transceiver is a WPAN modem. As discussed, Chan discloses its *appliance module 400* includes “a *Zigbee wireless chipset 405*” and may communicate using “a wireless RF signal” or “other wireless technologies, WiFi, *ZigBee*, *Bluetooth*, *WPAN*, RFID, *UWB*, infrared (IR), or other media.” (EX1004, [0070], [0073].)

193. First, Chan’s wireless network can be a WPAN. A POSITA would have understood (and found it obvious) that ZigBee, Bluetooth, and UWB are wireless personal area networks (WPANs). “*Zigbee*, *Bluetooth*, and *UWB*, [] have emerged to support a wide range of short distance wireless network applications.

These specifications are designed to be *compliant with the IEEE 802.15 standards*, a family of IEEE standards for short distance wireless networking called *Wireless Personal Area Networks (WPANs)*.” (EX1009, 601-602.)

194. Second, Chan discloses the antenna is a WPAN antenna and the wireless transceiver is a WPAN modem. Chan’s *appliance module* includes a “*Zigbee wireless chipset 405*” which includes a *transceiver* and an *antenna* for communicating with wireless sensors and devices *on the network* [e.g., ZigBee]. (*Supra* § IX.A.2.g; EX1004, [0008], [0073].) For example, the appliance module is equipped with a “*Zigbee wireless chipset 405*” and is thus a ZigBee device. (EX1004, [0008], [0073].) It was well-known that “[a] ZigBee network consists of ZigBee nodes (devices)” and each ZigBee device “consists of a microcontroller, a *transceiver*, and an *antenna*.” (EX1016, 34.) As ZigBee is a wireless personal area network (WPAN), it follows that the *transceiver* and *antenna* in the appliance module for communication via ZigBee would be a WPAN transceiver/modem and a WPAN antenna.

195. Further, Chan discloses “other chipsets could be utilized such as wireless chipsets for RF signals, WiFi, ZigBee, *Bluetooth*, *WPAN*, RFID, *UWB*, infrared (IR), or other media” in place of the “*Zigbee wireless chipset 405*.” (EX1004, [0070], [0067].) It would have been obvious to a POSITA that such “other . . . wireless chipset” includes a WPAN antenna and transceiver (e.g., a

Bluetooth antenna and transceiver, UWB antenna and transceiver, other WPAN antenna and transceiver). It would have been obvious to a POSITA that communication via wireless communications such as “Bluetooth, WPAN, UWB” utilizes a WPAN antenna (*e.g.*, Bluetooth antenna) and a WPAN transceiver/modem (*e.g.*, a Bluetooth transceiver/modem). It was well-known that “one-way (simplex) wireless communication requires a *transmitter* (*transmitter electronics* plus *antenna*) generating (electromagnetic) signals that can be properly received and deciphered by a *receiver* (*receiving electronics* plus *antenna*.) Bidirectional communication requires a pair of *transceivers*—each *transceiver* consists of a *transmitter* and a *receiver*.” (EX1018, 369.)

15. Claim 21: “The appliance according to claim 20, wherein the WPAN is according to, based on, or compatible with, Bluetooth™ or Institute of Electrical and Electronics Engineers (IEEE) 802.15.1-2005 standards.”

196. Chan discloses the WPAN is according to, based on, or compatible with, Bluetooth. As discussed above, Chan’s *appliance module* communicates using wireless technologies such as “ZigBee, *Bluetooth*, WPAN.” (*Supra* § IX.A.14; EX1004, [0070], [0073].) Thus, Chan discloses its appliance communicates over a WPAN based on Bluetooth. Further, Chan discloses “other chipsets. . . for . . . Bluetooth.” (EX1004, [0070], [0067]; *see also* EX1018, 369.)

16. Claim 22: “The appliance according to claim 20, wherein the WPAN is according to, based on, or compatible with, Zigbee™, IEEE 802.15.4-2003, or Z-Wave™ standards.”

197. Chan teaches the WPAN is compatible with *Zigbee* or *Z-Wave* standards. As discussed above, Chan discloses its *appliance module* communicates using wireless technologies such as “*ZigBee*, Bluetooth, WPAN” or “wireless technologies such as . . . *Zwave*.” (*Supra* § **Error! Reference source not found.**; EX1004, [0070], [0073], [0046].) Thus, Chan discloses its appliance communicates over a wireless personal area network based on *ZigBee* and *Z-wave*.

17. Claim 23: “The appliance according to claim 1, wherein the wireless network is a Wireless Local Area Network (WLAN), the antenna is a WLAN antenna, and the wireless transceiver is a WLAN modem.”

198. Chan discloses the wireless network is a Wireless Local Area Network (WLAN), the antenna is a WLAN antenna, and the wireless transceiver is a WLAN modem.

199. First, Chan discloses the wireless network is a WLAN. For example, Chan discloses its *appliance module 400* may communicate using “a wireless RF signal” or “other wireless technologies, *WiFi*, *ZigBee*, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0070], [0073].) A POSITA would have understood (and found it obvious) that a WiFi network is a WLAN. “Wireless local area networks (*WLANs*) are built around the family of IEEE 802.11 standards . . . The 802.11a/b/g family of standards are collectively referred

to as **Wi-Fi**, for wireless fidelity.” (EX1009, 558-559.) “**Wi-Fi** is a registered trademark owned by the Wi-Fi Alliance, and it refers to **wireless local area network (WLAN)** products that are based on the Institute of Electrical and Electronics Engineers’ (IEEE) 802.11 standards.” (EX1021, 7:48-51.) This is consistent with the description of the ’590 patent which states that “[i]n order to allow interoperability between equipment manufactured by different vendors, few **WLAN standards** have evolved, as part of the IEEE 802.11 standard group, **branded as WiFi** (www.wi-fi.org).” (EX1001, 8:25-32.)

200. Second, Chan discloses the antenna is a WLAN antenna and the wireless transceiver is a WLAN modem. As discussed above, Chan discloses that its appliance has “**a wireless transmitter and receiver** for communicating with wireless sensors and devices **on the network**,” and such network maybe “**WiFi**.” (EX1004, [0008], [0073].) It would have been obvious to a POSITA that the “**wireless transmitter and receiver**” is a WLAN transmitter and receiver (*i.e.*, a WLAN transceiver). (*Id.*)

201. Further, Chan discloses its **appliance module 400** includes “a Zigbee wireless chipset 405” and “other chipsets could be utilized such as **wireless chipsets** for RF signals, **WiFi**[.]” (EX1004, [0070], [0067].) It would have been obvious to a POSITA that such “wireless chipset” includes a WLAN antenna and transceiver (*e.g.*, a WiFi antenna and transceiver) because communication via

“WiFi” utilizes a WLAN antenna and a WLAN transceiver/modem. As discussed, it was well-known that “one-way (simplex) wireless communication requires a *transmitter* (*transmitter electronics* plus *antenna*) generating (electromagnetic) signals that can be properly received and deciphered by a *receiver* (*receiving electronics* plus *antenna*.) Bidirectional communication requires a pair of *transceivers*—each *transceiver* consists of a *transmitter* and a *receiver*.”

(EX1018, 369.) Further, WLAN devices equipped with WLAN transceiver and WLAN antenna for “send[ing] and receiv[ing] suitable information via a WLAN protocol” are well-known. (EX1022, 3:17-20, 3:38-40; *see also*, EX1023, [0013]-[0015].) Thus, a POSITA would have understood (and found it obvious) that to enable *Wi-Fi (WLAN) communication*, the appliance module would include a *WLAN transceiver (modem)* and a *WLAN antenna*. (EX1018, 369.)

18. Claim 24: “The appliance according to claim 23, wherein the WLAN is according to, based on, or compatible with, IEEE 802.11-2012, IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, IEEE 802.11n, or IEEE 802.11ac.”

202. Chan discloses the WLAN is according to, based on, or compatible with, IEEE 802.11a, IEEE 802.11b, or IEEE 802.11g. As discussed above, Chan discloses its *appliance module 400* may communicate using “a wireless RF signal” or “other wireless technologies, *WiFi*, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0070], [0073].)

203. A POSITA would have understood (and found it obvious) that WiFi is based on the IEEE 802.11 standards which include the 802.11a/b/g family. For example, Goldsmith discloses that “[w]ireless local area networks (*WLANs*) are built around the family of *IEEE 802.11 standards* . . . *The 802.11a/b/g family* of standards are collectively referred to as *Wi-Fi*, for wireless fidelity.” (EX1009, 558-559.) “*Wi-Fi* is a registered trademark owned by the Wi-Fi Alliance, and it refers to *wireless local area network (WLAN)* products that are based on the Institute of Electrical and Electronics Engineers’ (*IEEE*) *802.11 standards*.” (EX1021, 7:48-51.) This is consistent with the description of the ’590 patent which states that “[i]n order to allow interoperability between equipment manufactured by different vendors, few *WLAN standards* have evolved, as part of the *IEEE 802.11 standard group, branded as Wi-Fi* (www.wi-fi.org). IEEE 802.11b describes a communication using the 2.4 GHz frequency band and supporting communication rate of 11 Mb/s, IEEE 802.11a uses the 5 GHz frequency band to carry 54 MB/s and IEEE 802.11g uses the 2.4 GHz band to support 54 Mb/s.” (EX1001, 8:25-32.)

204. Thus, Chan discloses or certainly suggests a wireless network based on WLAN that is according to, based on, or compatible with IEEE 802.11a, IEEE 802.11b, IEEE 802.11g.

19. Claim 25: “The appliance according to claim 1, wherein the wireless network is a wireless broadband network.”

205. Chan discloses the wireless network is a wireless broadband network. As discussed, Chan discloses its *appliance module 400* may communicate using “a wireless RF signal” or “*other wireless technologies*, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or *other media*.” (EX1004, [0070], [0073].) Further, Chan’s *appliance module 400* communicates with the gateway, which has “communication ports being configured for at least one format selected from . . . *WiMax*.” (EX1004, Claim 2.) It would have been obvious to implement the *appliance module* to provide WiMAX connectivity such that *appliance module* communicates with the gateway via WiMAX. 1004Thus, Chan discloses that its appliance may communicate via WiMAX.

206. A POSITA would have understood (and found it obvious) that WiMax is a *wireless broadband network*. For example, Goldsmith discloses that “*WiMAX* is an emerging *broadband wireless technology* based on the IEEE 802.16 standard [20, 21]. The core 802.16 specification is a standard for broadband wireless access systems operating at radio frequencies between 10 GHz and 66 GHz.” (EX1009, 17.)

20. Claim 26: “The appliance according to claim 1, wherein the wireless network uses a licensed or unlicensed radio frequency band.”

207. I note that the claim requires either a licensed or unlicensed radio frequency band, which encompasses all possible radio frequency bands. Chan, which its *appliance module 400* may communicate using “a wireless RF [*i.e.*, radio frequency] signal” satisfies this limitation. (EX1004, [0070], [0073].)

208. For example, Chan discloses the wireless network uses an unlicensed radio frequency bands. As discussed, Chan discloses its *appliance module 400* may communicate using “*a wireless RF* signal” or “other wireless technologies, *WiFi*, ZigBee, *Bluetooth*, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0070], [0073].)

209. A POSITA would have understood (and found it obvious) that both Bluetooth and WLAN over 802.11b and 802.11g are unlicensed radio frequency bands. For example, Goldsmith discloses that “[m]any extremely successful wireless systems operate in *unlicensed bands*, including *wireless LANs*, *Bluetooth*, and cordless phones.” (EX1009, 21.) Further, Goldsmith summarized in the table below regarding “unlicensed radio frequency spectrum allocations in the U.S.” that the spectrums include 2.4-2.4835 GHz and 5.15-5.25 GHz, covering Bluetooth, 802.11b WLANs, and 802.11a WLANs. (EX1009, 18-19, 23.)

Table 1.2: Unlicensed U.S. spectrum allocations

Band	Frequency
ISM band I (cordless phones, 1G WLANs)	902–928 MHz
ISM band II (Bluetooth, 802.11b and 802.11g WLANs)	2.4–2.4835 GHz
ISM band III (wireless PBX)	5.725–5.85 GHz
U-NII band I (indoor systems, 802.11a WLANs)	5.15–5.25 GHz
U-NII band II (short-range outdoor systems, 802.11a WLANs)	5.25–5.35 GHz
U-NII band III (long-range outdoor systems, 802.11a WLANs)	5.725–5.825 GHz

210. Further, “[w]ireless networks operate today in what are called unlicensed frequencies . . . The common public *unlicensed frequency bands* (in the United States) are 900 MHz, 2.4 GHz, and 5.1 GHz . . . *802.11b*, *802.11g*, and *802.11n networks* are operate in the 2.4-GHz band.” (EX1013, 229-230.)

211. Thus, Chan’s *appliance module 400*, which communicates over Bluetooth and WiFi, uses unlicensed frequency bands.

21. Claim 27: “The appliance according to claim 26, wherein the unlicensed radio frequency band is an Industrial, Scientific and Medical (ISM) radio band.”

212. Chan discloses the unlicensed radio frequency band is an Industrial, Scientific and Medical (ISM) radio band. As discussed, Chan discloses its *appliance module 400* may communicate using “a wireless RF signal” or “other wireless technologies, *WiFi*, ZigBee, *Bluetooth*, WPAN, RFID, UWB, infrared (IR), or other media.” (EX1004, [0070], [0073].)

213. A POSITA would have understood (and found it obvious) that both Bluetooth and WLAN over 802.11b and 802.11g communicate using *ISM* radio bands. (EX1009, 18-19, 23, Table 1.2.)

Table 1.2: Unlicensed U.S. spectrum allocations	
Band	Frequency
ISM band I (cordless phones, 1G WLANs)	902–928 MHz
ISM band II (Bluetooth, 802.11b and 802.11g WLANs)	2.4–2.4835 GHz
ISM band III (wireless PBX)	5.725–5.85 GHz
U-NII band I (indoor systems, 802.11a WLANs)	5.15–5.25 GHz
U-NII band II (short-range outdoor systems, 802.11a WLANs)	5.25–5.35 GHz
U-NII band III (long-range outdoor systems, 802.11a WLANs)	5.725–5.825 GHz

214. Thus, Chan’s *appliance module 400*, which communicates over Bluetooth and WiFi, uses unlicensed, *ISM* frequency bands.

22. Claim 29: “The appliance according to claim 1, wherein the wireless network is a WiMAX network, wherein the antenna is a WiMAX antenna and the wireless transceiver is a WiMAX modem, and wherein the WiMAX network is according to, or based on, or compatible with, IEEE 802.16-2009.”

215. Chan discloses the wireless network is a WiMAX network, wherein the antenna is a WiMAX antenna and the wireless transceiver is a WiMAX modem, and wherein the WiMAX network is according to, or based on, or compatible with, IEEE 802.16-2009

216. First, Chan discloses the wireless network is a WiMAX network. Chan’s *appliance module 400* may communicate using “a wireless RF signal” or “*other wireless technologies*, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB,

infrared (IR), or *other media*.” (EX1004, [0070], [0073].) Further, Chan’s *appliance module 400* communicates with the gateway, which has “communication ports being configured for at least one format selected from . . . *WiMax*.” (EX1004, Claim 2.) It would have been obvious to implement the *appliance module* to provide WiMAX connectivity such that *appliance module* communicates with the gateway. Thus, Chan discloses that its appliance communicates via WiMAX.1004

217. Second, Chan’ discloses the WiMAX network is according to, or based on, or compatible with, IEEE 802.16-2009. A POSITA would have understood (and found it obvious) that WiMAX is a wireless broadband network according to, or based on, or compatible with, IEEE 802.16-2009. For example, Goldsmith discloses that “*WiMAX* is an emerging *broadband wireless technology* based on the *IEEE 802.16 standard* [20, 21].” (EX1009, 17.) It would have been obvious to a POSITA at the time of the invention to use a recent IEEE 802.16 standard, such as IEEE 802.16-2009, for implementing Chan’s WiMAX network.

218. Third, Chan discloses the antenna is a WiMAX antenna and the wireless transceiver is a WiMAX modem. Chan’s appliance includes “a *wireless transmitter and receiver* for communicating with wireless sensors and devices *on the network*,” and such network is “*WiMax*,” it would have been obvious to a POSITA that the “*wireless transmitter and receiver*” includes a WiMax

transmitter and receiver (*i.e.*, a WiMax transceiver). (EX1004, [0008], [0073].)

Further, Chan discloses its *appliance module 400* includes “a Zigbee wireless chipset 405” and “other chipsets could be utilized such as *wireless chipsets* for RF signals, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or *other media*.” (EX1004, [0070], [0067].) It would have been obvious to a POSITA that such “wireless chipset” includes a WiMAX antenna and transceiver. As discussed, it was well-known that wireless communication utilizes “a *transmitter (transmitter electronics plus antenna)* generating (electromagnetic) signals” and “a *receiver (receiving electronics plus antenna)*.” (EX1018, 369.) A POSITA would have understood (and found it obvious) that wireless communication via WiMAX networks would utilize a WiMAX antenna and a WiMAX modem (*e.g.*, a WiMAX transceiver).

23. Claim 30: “The appliance according to claim 1, wherein the wireless network is a cellular telephone network, the antenna is a cellular antenna, and the wireless transceiver is a cellular modem.”

219. Chan discloses the wireless network is a cellular telephone network, the antenna is a cellular antenna, and the wireless transceiver is a cellular modem.

220. First, Chan discloses the wireless network is a cellular telephone network. Chan’s *appliance module 400* communicates using “a wireless RF signal” or “*other wireless technologies*, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or *other media*.” (EX1004, [0070], [0073].) Chan’s

appliance module 400 communicates with the gateway, which has “communication ports being configured for at least one format selected from ... ***GSM, Cellular.***” (EX1004, Claim 2.) It would have been obvious to implement the *appliance module* to provide cellular connectivity such that *appliance module* communicates with the gateway via the cellular network. 1004 Thus, Chan’s *appliance module* communicates via a cellular network.

221. Second, Chan discloses the antenna is a cellular antenna and the wireless transceiver is a cellular modem. For example, Chan discloses that its appliance has “a *wireless transmitter and receiver* for communicating with wireless sensors and devices ***on the network.***” (EX1004, [0008], [0073].) Since such network includes “***GSM, Cellular,***” it would have been obvious to a POSITA that the “*wireless transmitter and receiver*” is a cellular transmitter and receiver (*i.e.*, a cellular transceiver). (EX1004, Claim 2, [0008], [0073].)

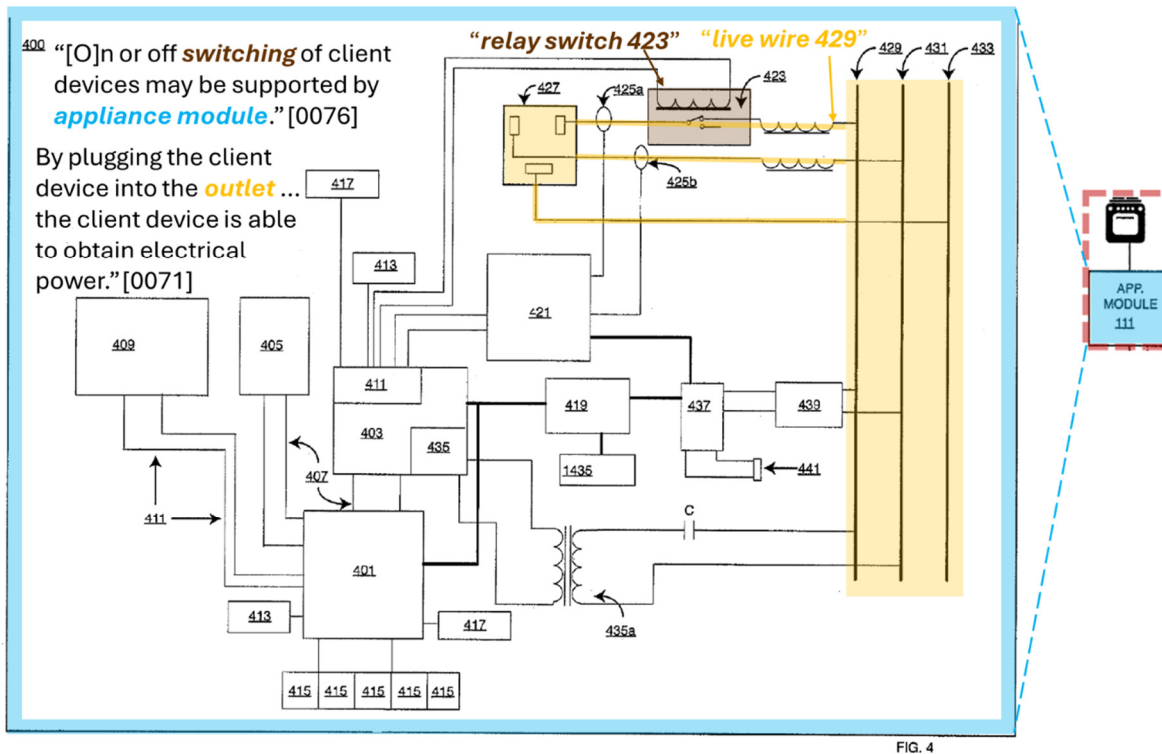
222. Further, Chan discloses its *appliance module 400* includes “a Zigbee wireless chipset 405” and “other chipsets could be utilized such as ***wireless chipsets*** for RF signals, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or ***other media.***” (EX1004, [0070], [0067].) It would have been obvious to a POSITA that such “wireless chipset” includes a cellular antenna and transceiver. As discussed, it was well-known that wireless communication utilizes “a *transmitter* (*transmitter electronics* plus *antenna*) generating (electromagnetic)

signals” and “a *receiver* (*receiving electronics* plus *antenna*. Bidirectional communication requires a pair of *transceivers*—each *transceiver* consists of a *transmitter* and a *receiver*.” (EX1018, 369.) Further, cellular transceivers and antennas were well-known. “[W]ireless mobile devices are being made with integrated WLAN transceivers and wireless wide area network (WWAN) transceivers, such as *cellular* and/or paging *transceivers*.” (EX1022, 1:20-23.)

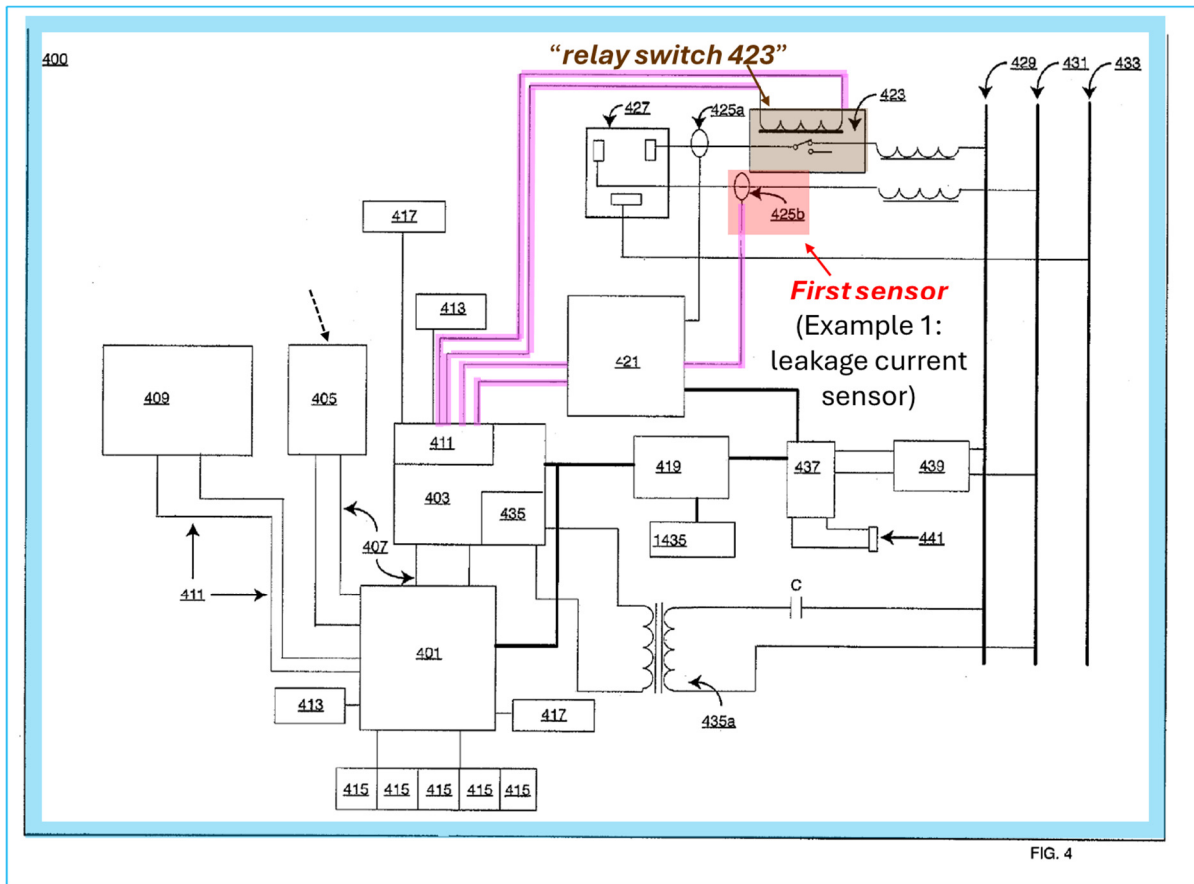
223. Thus, a POSITA would have understood (and found it obvious) that communication via cellular networks would utilize a cellular antenna and a cellular modem (*e.g.*, a cellular transceiver).

24. Claim 32: “The appliance according to claim 1, further comprising an electrically actuated switch connected to switch electric power to at least part of the appliance, the switch is coupled to the first sensor for being activated in response to the physical phenomenon.”

224. Chan teaches *the electrically actuated switch* connected to switch electric power to at least part of the appliance, and coupled to the first sensor for being activated in response to the physical phenomenon. For example, Chan’s *appliance module* includes a *relay switch 423*. (EX1004, [0070].) As discussed above, *relay switch 423* is an electrically actuated switch configured to switch electric power to at least part of the appliance. (*Supra* §IX.A.7.)



225. Chan also discloses that **current transformer 425b** is a sensor having an output that responds to physical phenomenon. (*Supra* § IX.A.2.f.) As shown in FIG. 4, the **relay switch 423** is coupled to current transformers (CT) 425a and **current transformer 425b** through powerline module 403 and power measure module 421. (EX1004, FIG. 4.) For example, **appliance module 400** includes a “powerline module 403 [that] includes... [an] I/O port 411 ... **connected to**...a power measure module 421...connected to ... two (2) **current transformers (CT)** 425a and **425b**.” (EX1004, [0070].)



226. It would be obvious to a POSITA that the *relay switch 423* is activated in response to the physical phenomenon (*e.g.*, leakage current) detected by *current transformer 425b*. For example, Chan states “*appliance module* [] may also be used for determining or locating client devices responsible for ‘vampire’ current and how much such leaks cost.” (EX1004, [0070], [0075].) Thus, it would have been obvious that, for example, upon detection of leakage current (*e.g.*, over a threshold) by *current transformer 425b*, *relay switch 423* can disconnect power to the appliance, thereby enabling real-time reporting and remediation of the leakage.

227. A POSITA would have understood (and found it obvious) that such local control (*e.g.*, automatic disconnection) can operate in parallel with or in coordination with remote control and reporting functions (*e.g.*, wireless transmission of leakage data). For example, the *current transformer 425b* can detect and wirelessly transmit leakage current data to the gateway, as well as trigger the relay switch to interrupt the power supply if the leakage exceeds a safety or energy-efficiency threshold. These mechanisms can function simultaneously or cooperatively, providing both local protection and remote monitoring.

228. Thus, a POSITA would have understood that the switch would be activated in response to the physical phenomenon captured by the first sensor (*e.g.*, *current transformer 425b*.)

229. As shown in FIG. 4, the *relay switch 423* is also *coupled to temperature and humidity sensor 409*. A POSITA would have understood (and found it obvious) that the *relay switch 423* is activated in response to the physical phenomenon detected by the *temperature and humidity sensor 409*. When the *temperature and humidity sensor 409* detects environmental conditions indicating abnormal operation—such as excessive temperature, humidity, or load—the *appliance module* can trigger *relay switch 423* to interrupt power or adjust operation. A POSITA would have recognized that such activation in response to

sensed temperature or humidity conditions enables automated protection of the appliance and enhanced energy-management control.

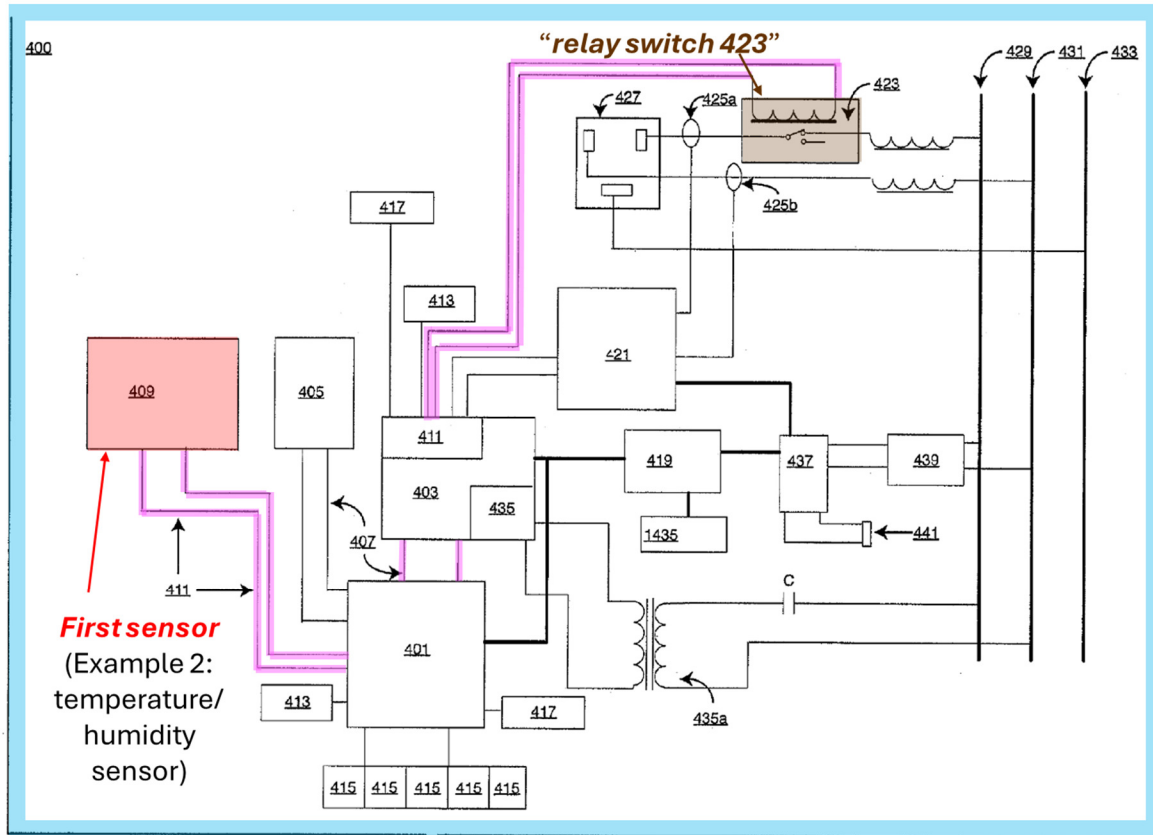


FIG. 4

25. Claim 38: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, an atmospheric or an environmental sensor.”

230. Chan discloses the first sensor consists of, or comprises, an atmospheric or an environmental sensor. As discussed above, Chen discloses its *appliance module 400* includes “a *temperature and humidity sensor 409*” which is a *first sensor* having an output that responds to a physical phenomenon. (EX1004, [0070], [0109], FIG. 4.) Chan describes other *first sensors* that are

integrated into the appliance module, including a

“temperature/fog/brightness/infrared sensor 1107,” “a thermal sensor,” “a humidity sensor,” “pressure sensors,” “microphones,” “vibration sensors,” or “smoke sensors.” (EX1004, [0070], [0109], Claims 3-16.)

231. A POSITA would have understood (and found it obvious) that such sensors are environmental sensors that sense environmental data. This is consistent with the '590 patent, which discloses “[a] sensor may respond to *environmental* conditions such as *temperature, humidity, noise, vibration, fumes, odors, toxic conditions, dust, and ventilation.*” (EX1001, 63:57-59; *see also* 65:18-20 (“The environmental related sensor may respond to humidity, air pressure, and air temperature.”).)

232. Further, POSITA would have understood (and found it obvious) that a *temperature/fog sensor* or a *humidity* sensor is an atmospheric environmental sensor. Humidity is the “water content in the surrounding air” “water vapor content in gases.” (EX1012, 445-446.) For example, absolute humidity is “a function of atmospheric pressure” and “absolute humidity is the density of water vapor component. It can be measured, for example, by passing a measured quantity of air through a moisture-absorbing substance (such as silica-gel) that is weighed before and after the absorption.” (EX1012, 446.)

26. Claim 41: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, a photoelectric sensor that responds to a visible or an invisible light, and wherein the invisible light is infrared, ultraviolet, X-rays, or gamma rays.”

233. Chan discloses the first sensor comprises a photoelectric sensor that responds to a visible or an invisible light, and wherein the invisible light is infrared, ultraviolet, X-rays, or gamma rays. As discussed above, Chan discloses its *appliance module 400* includes “a *temperature and humidity sensor 409*” which is a *first sensor* having an output that responds to a physical phenomenon. (EX1004, [0070], [0109], FIG. 4.) Chan describes other *first sensors* that are integrated into the appliance module, including a

“*temperature/fog/brightness/infrared sensor 1107*,” “*a light sensor*,” or “one or more combinations of sensor devices.” (EX1004, [0070], [0109], Claims 7, 16.)

234. A POSITA would have understood (and found it obvious) that a *light sensor* consists of or comprises a photoelectric sensor that responds to a visible or an invisible light. “Detectors of electromagnetic radiation in the spectral range from *ultraviolet* to far infrared are called light detectors.” (EX1012, 461-465.) “The process of optical detection involves the direct conversion of optical energy (in the form of photons) into an electrical signal (in the form of electrons).” (EX1012, 466.)

235. Further, Chan expressly discloses the first sensor may be a “temperature/fog/brightness/*infrared sensor 1107*,” which is a photoelectric sensor that responds to *invisible, infrared* light. (EX1004, [0070], [0109].)

27. Claim 44: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, a photosensitive image sensor array comprising multiple photoelectric sensors, for capturing an image and producing electronic image information representing the image, and the appliance further comprising one or more optical lens for focusing the received light and to guide the image, and wherein the image sensor is disposed approximately at an image focal point plane of the one or more optical lens for properly capturing the image.”

236. Chan discloses “the first sensor consists of, or comprises, a photosensitive image sensor array comprising multiple photoelectric sensors, for capturing an image and producing electronic image information representing the image, and the appliance further comprising one or more optical lens for focusing the received light and to guide the image, and wherein the image sensor is disposed approximately at an image focal point plane of the one or more optical lens for properly capturing the image.”

237. A POSITA would have understood (and found it obvious) that the claim describes a camera. This is consistent with the ’590 patent. (EX1001, 17:55-18:25 (“A sensor may be an image sensor for providing *digital camera functionality*, allowing an image (either as still images or as a video) to be captured, stored, manipulated and displayed. The image capturing hardware

integrated with the sensor unit may contain a photographic lens (through a lens opening) focusing the required image onto a photosensitive image sensor array disposed approximately at an image focal point plane of the optical lens, for capturing the image and producing electronic image information representing the image.”); *see also* EX1012, 478, 480, 497-498.)

238. Chan discloses an “**IP camera**” connected to the **appliance module**. (EX1004, [0076].) Such “IP camera may generate a high-bandwidth data signal which may be transmitted by appliance module 400 across network infrastructure to a desired location or received by gateway 300.” (*Id.*) It would have been obvious to house the camera in the appliance module for monitoring purposes. Further, Chan discloses the **appliance module** also includes a “**security sensor**” and a “**motion sensor**,” which a POSITA would understand to include cameras. This is consistent with the disclosures of the ’590 patent which states “[a] **motion detector** may be based on sound (acoustic sensors), opacity (optical and infrared sensors and **video image processors**)[.]” (EX1001, 21:3-10.)

239. A POSITA would have understood (and found it obvious) that such cameras to include photosensitive image sensor arrays comprising multiple photoelectric sensors for capturing an image and producing electronic image information representing the image. “The **charge-coupled device (CCD) and complementary metal oxide semiconductor (CMOS) image sensors** are two

different technologies presently used for *capturing images* digitally . . . Both types of imagers *convert light into electric charge and process it into electronic signals.*” (EX1012, 478.) “Like CCDs, CMOS imagers include an *array of photosensitive diodes (PD)*, one diode within each pixel.” (EX1012, 480.)

240. It would have been obvious for a POSITA to further include one or more optical lens in Chan’s appliance module for focusing the received light and to guide the image. Fraden discloses that “[a]n optical sensor usually operates in conjunction with some kind of an optical system that may be as simple as a window or spectral filter. Often, an optical system includes *lenses*, mirrors, fiber optics, and other elements that *alter direction of light.*” (EX1012, 497.) Fraden discloses the benefits of including a focusing lens to improve the efficiency of a photoelectric imaging sensor. “In most cases, the sensor’s output signal is proportional to the received photonic power, which, in turn, proportional to the sensor’s surface area (input aperture). Yet, the sensing area is usually small. For example, a thermopile pixel of the sensor shown in Fig. 14.21a has a sensing area 0.022 mm², and thus it will receive a very small portion of the photon flux emanated from the object. Figure 14.30b shows that the use of a *focusing lens can dramatically increase the received light flux.* This is because the entire lens aperture receives the flux and, *like a funnel, brings it to a small sensor.*” (EX1012, 497-498.) It would be obvious for a POSITA to include lenses that

operate in conjunction with the imaging sensor (*e.g.*, in an IP camera, motion sensor, or security sensor) to focus the received light and to guide the image.

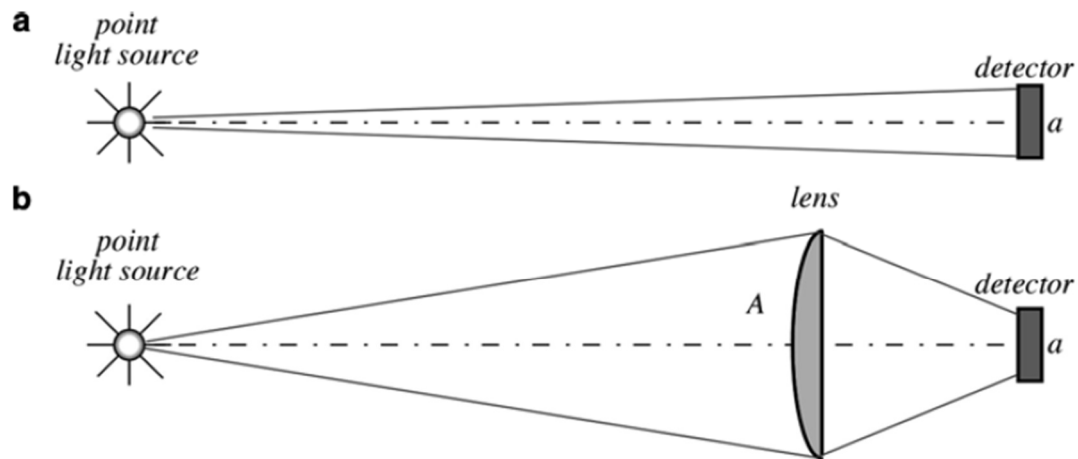


Fig. 14.30 Efficiency of a detector depends on (a) its surface area a and (b) the input aperture A of the focusing system

241. It would have been obvious to a POSITA that Chan's image sensor is disposed approximately at an image focal point plane of the one or more optical lens for properly capturing the image, especially due to the well-known benefits discussed above of including lens in the optical detection system to focus received light and direct it to the image sensor. The image sensor is thus placed approximately at an image focal point plane of the one or more optical lens, such as the sample configuration shown in FIG. 14.30 above.

28. Claim 45: “The appliance according to claim 44, further comprising an image processor coupled to the image sensor for providing a digital data video signal according to a digital video format, the digital video signal carrying the digital data video based on the captured images, and wherein the digital video format is based on one out of: TIFF (Tagged Image File Format), RAW format, AVI, DV, MOV, WMV, MP4, DCF (Design Rule for Camera Format), ITU-T H.261, ITU-T H.263, ITU-T

H.264, ITU-T CCIR 601, ASF, Exif (Exchangeable Image File Format), and DPOF (Digital Print Order Format) standards.”

242. Chan discloses an image processor coupled to the image sensor for providing a digital data video signal according to a digital video format, the digital video signal carrying the digital data video based on the captured images, and wherein the digital video format is based on one out of: TIFF, AVI, MOV, WMV, MP4, or ASF.

243. A POSITA would have understood (and found it obvious) that this language describes a digital video camera. This is consistent with the '590 patent. (EX1001, 17:55-18:25 (“A sensor may be an image sensor for providing *digital camera functionality*, allowing an image (either as still images *or as a video*) to be captured, stored, manipulated and displayed.”); *see also* EX1012, 478, 480, 497-498.)

244. First, Chan discloses an image processor coupled to the image sensor for providing a digital data video signal according to a digital video format. For example, Chan describes an “*IP camera*” connected to the *appliance module*. EX1004, [0076].) Such “IP camera may generate a high-bandwidth data signal which may be transmitted by appliance module 400 across network infrastructure to a desired location or received by gateway 300.” (*Id.*) A POSITA would understand such *IP camera* to be a digital video camera. It would have been

obvious to house the *IP camera* in the appliance module for monitoring purposes and to support compact and efficient design.

245. Further, Chan discloses the *appliance module* also includes a “*security sensor*” and a “*motion sensor*,” which a POSITA would understand to include digital video cameras. 1004For example, Fraden discloses various types of occupancy and motion detectors including “[p]hotoelectric: interruption of light beams by moving objects,” “[v]*ideo motion detectors*: a video equipment that compares a stationary image stored in memory with the current image from a protected area.” (EX1012, 247-248.) This is consistent with the disclosures of the ’590 patent which states “[a] *motion detector* may be based on sound (acoustic sensors), opacity (optical and infrared sensors and *video image processors*)[.]” (EX1001, 21:3-10; *see also Id.*, 38:57-66 (“The image sensor may be a digital sensor for capturing digital video content, and the image processor may be operative for enhancing the video content such as . . . for Video Content Analysis (VCA) such as *Video Motion Detection (VMD)*, . . . *motion detection*, object detection[.]”).)

246. The POSITA would understand such video cameras utilize an image processor coupled to the image sensor for providing a digital data video signal according to a digital video format. For example, “[t]he *charge-coupled device (CCD) and complementary metal oxide semiconductor (CMOS) image sensors*

are two different technologies presently used for *capturing images* digitally . . .

Both types of imagers *convert light into electric charge and process it into electronic signals.*” (EX1012, 478.) Further, “[b]ecause CMOS imagers are created in the same process as *processors*, memories, and other major components, CMOS imagers can integrate with these same components onto a single piece of silicon.” (EX1012, 480.) Likewise, Wiedemann describes a conventional video camera that includes a CCD image sensor coupled to a digital signal processor (DSP) which “converts the digital images from [the] CCD physical space format into a display space format,” thereby generating a digital video signal suitable for output and use by other systems. (EX1049, 1:28-2:12.) Wiedemann thus confirms that video cameras employ an image processor coupled to the image sensor to produce a digital data video signal according to a defined digital video format.

247. The POSITA would understand the video format to correspond to a standard digital video format. For example, “Non-limiting examples of Video formats and containers include: MJPEG, Motion JPEG 2000, MPEG-1, MPEG-2, MPEG-4 ASP, MPEG-4/AVC, H.120, H.261, H.262, H.263, H.264, AMV, AVS, Dirac, Indeo, Pixlet, RealVideo, RTVideo, SheerVideo, Smacker, Snow, Theora, VC-1, VP6, VP7, *WMV*, 3GP, *ASF*, *AVI*, Bink, DMF, DPX, FLV, Matroska, *MP4*, MXF, NUT, Ogg, Ogg Media, QuickTime *MOV*, RealMedia, Smacker, RIFF, VOB, AIFF, AU, WAV, Shockwave SWA. Non-limiting

examples of Image formats include: JPEG, JPEG 2000, lossless JPEG, JBIG, JBIG2, PNG, WBMP, BMP, GIF, ICER, ILBM, PCX, PGF, TGA, TIFF[.]”

(EX1026, [0048].)

29. Claim 46: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, an electrochemical sensor that responds to an object chemical structure, properties, composition, or reactions.”

248. Chan discloses the first sensor consists of, or comprises, an electrochemical sensor that responds to an object chemical structure, properties, composition, or reactions. For example, Chan describes other *first sensors* that are integrated into the *appliance module*, such as “one or more *smoke sensors*.”

(EX1004, [0070], [0109], Claims 14, 16.)

249. Smoke sensors are electrochemical sensors. For example, “[c]hemical sensors respond to stimuli produced by various chemicals or *chemical reactions*. These sensors are intended for identification and quantification of chemical species (including both liquid and gaseous phases).” (EX1012, 569.) Chemical sensors include “(1) sensors that measure electrical or *electrochemical properties*, (2) those that measure a change in a physical property, (3) and those that rely on optical absorption.” (EX1012, 572.)

250. “*The electrochemical sensors* are commercially available and very versatile. Depending on the operating mode, they are divided into sensors that

measure voltage (potentiometric), those that measure electric current (amperometric), and those that rely on the measurement of conductivity or resistivity (conductometric). In all these methods, special electrodes are used, where either a *chemical reaction* takes place or the charge transport is modulated by the reaction.” (EX1012, 575-576.)

251. A POSITA would have understood (and found it obvious) that smoke sensors are electrochemical sensors commonly based on an ionization. Regarding ionization detectors, Fraden discloses that “[t]his detector is especially useful for *detecting smoke* composed of very small particles (submicron) like those generated by large hot fires. The key part of this type of sensor is an ionization chamber containing less than a milligram of radioactive element Americium-241 (Am241). When smoke is drawn into the ionization chamber between the plates, the smoke particles absorb alfa-radiation, thus reducing *air ionization* and subsequently current *i* drops. This increases voltage at input of the amplifier, manifesting presence of smoke inside the ionization chamber.” (EX1012, 424-426.)

252. This is consistent with the description of the ’590 patent which explains that “[t]he sensor may be an electrochemical sensor and may respond to an object chemical structure, properties, composition, or reactions . . . The electrochemical sensor may be a smoke, a flame, or a fire detector, and may be

based on optical detection or on ionization for responding to combustible, flammable, or toxic gas.” (EX1001, 36:15-23.)

30. Claim 53: “The appliance according to claim 1, further comprising in the single enclosure an actuator for affecting the physical phenomenon, wherein the actuator is coupled to the wireless transceiver for being activated or controlled in response to digital data received from the wireless network.”

253. Chan discloses an *actuator* in the *single enclosure* for affecting the physical phenomenon, wherein the *actuator* is coupled to the *wireless transceiver* for being activated or controlled in response to digital data received from the wireless network.

254. First, Chan discloses an *actuator* housed in the *single enclosure*. For example, Chan’s *appliance module* (i.e., the *single enclosure*) includes a *relay switch 423*. (EX1004, [0070].) As discussed above, *relay switch 423* is an electrically actuated switch configured to switch electric power to at least part of the appliance. (*Supra* §IX.A.7.) Chan’s *relay switch 423* is an actuator, consistent with the ’590 patent. (EX1001, 90:14-20 (“part of an actuator 15 unit 60a is shown, including a controlled switch 601 which is corresponding to the actuator 61, connected between a power source 56a and a power consuming circuit or load 58. The switch 601 may be implemented by a relay.”); 92:42-45.)

255. Second, activation of *relay switch 423* *affects the physical phenomena* detected by the *first sensor* (e.g., *CT 425b* or *temperature and*

humidity sensor 409). When the first sensor, *CT 425b*, detects leakage current on the neutral wire, using *relay switch 423* to disconnect power to the appliance, *stops the current flow that produces the leakage current* detected by *CT 425b*.

Likewise, when *temperature and humidity sensor 409* detects excessive temperature conditions, activating *relay switch 423* to interrupt power to the appliance stops further heat generation, allowing *the temperature to decrease*.

Thus, *relay switch 423* functions as an actuator that, when activated, directly *affects the physical phenomena* sensed by *CT 425b* or *temperature and humidity sensor 409*.

256. Third, the *actuator* is coupled to the *wireless transceiver* for being activated or controlled in response to digital data received from the wireless network. As shown in FIG. 4, *relay switch 423* is coupled to the ZigBee wireless chipset 405 through control unit 401 and powerline module 403. (EX1004, FIG. 4.) For example, appliance module 400 includes “a Central Processing Unit (CPU) 401 that is connected to a powerline chipset 403 and a ZigBee wireless chipset 405 through a RS232 serial interface 407.” (EX1004, [0070].)

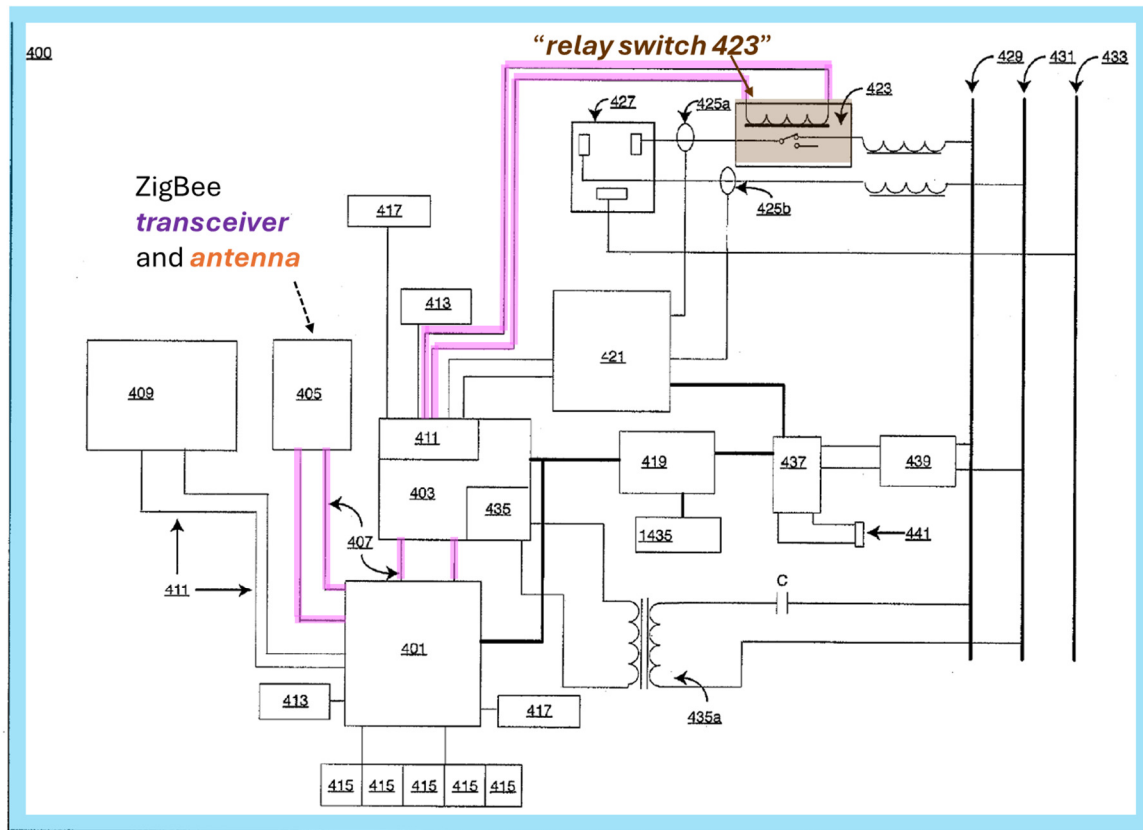


FIG. 4

257. Fourth, **relay switch 423** is activated or controlled in response to digital data received from the wireless network. Chan explains that “a low-bandwidth signal may carry command or control information from gateway 300 ... and turn the connected appliance on or off,” and that such signals are transmitted using “wireless signal technology.” (EX1004, [0057].) Thus, when the gateway transmits command data over the wireless network, the ZigBee wireless chipset 405 receives the digital information, which the CPU 401 uses to activate **relay switch 423** and switch power to the connected appliance. A POSITA would have recognized that this operation demonstrates **relay switch 423** is activated or

controlled in response to digital data received from the wireless network. (*Supra* §§IX.A.8, IX.A.23.)

B. Ground 2: Chan in view of Botts Render Obvious Claims
50-52

1. Summary of Botts

258. Botts was filed on November 11, 2008, before the earliest provisional application filing date of the '590 patent, and thus qualifies as prior art under §102(e). (EX1006, 1.) The Examiner never found, and Applicant never cited, Botts during prosecution.

259. Botts is analogous to the field of the '590 patent. Both relate to energy monitoring and control of household appliances through sensors and network communication. (EX1001, 81:60-82:54, 83:39-55; EX1006; 1:6-9, 1:65-2:8.)

260. Botts generally “relates to a household appliance, and particularly, to a household appliance that monitors energy usage, and more particularly, to a system and method of monitoring energy usage for a household appliance.” (EX1006, 1:6-9.)

261. Botts discloses “provid[ing] a household appliance having an internal energy usage monitor that detects or monitors the energy usage for an appliance . . . Aspects of the present invention can detect or monitor the energy usage for

subsystems within an appliance, which may provide valuable information with respect to energy usage.” (EX1006, 1:65-2:8.)

262. Botts recognizes that “the environmental conditions in which the appliance is operating can affect the energy usage of the appliance.” (EX1006, 2:9-11.) Accordingly, “aspects of the present invention provide an energy usage monitor that takes into account environmental conditions of the location of the appliance.” ((EX1006, 2:11-14.)

2. Motivation to combine Chan and Botts

263. A POSITA would have been motivated to combine Chan and Botts. Both Chan and Botts are analogous to the '590 patent and all relate to energy monitoring in household appliances. Chan discloses an energy monitoring and control network in which the appliance module measures, stores, and reports energy consumption data of connected household devices such as refrigerators, washers and dryers, ranges, stoves, and microwaves. (EX1004, [0045], [0047], [0071].) Botts generally relates to “a system and method of monitoring energy usage for a household appliance” where the household appliance is provided with “an internal energy usage monitor that detects or monitors the energy usage for an appliance.” (EX1006, 1:6-9, 1:65-2:8.) Thus, both references are from the same field of endeavor and are reasonably pertinent to the same technical problem of monitoring and communicating appliance energy consumption.

264. Chan's appliance module already measures current and power consumption using sensors such as current transformers (CTs 425a and 425b) and transmits the information with a gateway and controls the appliance accordingly. (EX1004, [0047], [0057], [0070]-[0071].) Botts discloses the addition of color indicator lights to visually communicate to a user the appliance's energy usage level and efficiency. (EX1006, 10:56-67.) Incorporating Botts's visual feedback mechanism into Chan's energy monitoring appliance module would have been an obvious and predictable improvement. The Chan-Botts combination would allow Chan's appliance module to provide real-time visual indications of energy consumption directly to the user as taught by Botts. For example, the appliance module in Chan could illuminate colored indicators or display icons corresponding to the instantaneous current readings from its built-in current sensors, thereby allowing users to recognize high or low energy usage without accessing a separate gateway or digital interface. Such a combination would have predictably improved user convenience and overall usability of the system.

265. Moreover, a POSITA would have recognized that both Chan and Botts' systems are adaptable to a wide range of household appliances. Chan explicitly teaches that the appliance module is implemented with different appliances including, refrigerators, washers and dryers, ranges, stoves, and microwaves. (EX1004, [0047].) Botts likewise discloses applying its energy

monitoring system to a variety of household appliances such as “an oven or wall oven, a range, a cooktop, a microwave, a dishwasher, a washing machine, a dryer, an exhaust fan or vent, a heated or cooled built-in drawer, such as a drawer configured to dry and store dishes, eating utensils, and cooking utensils such as pots and pans.” (EX1006, 4:20-25.) Thus, combining the Chan and Botts would predictably extend Chan’s energy monitoring network to additional household devices such as dishwashers, dryers, eating utensils etc. Further, there was a finite number of household appliances such as televisions, washing machines, air conditioners, that were commonly available and can be readily incorporated into Chan’s energy monitoring system at the time of the invention.

266. The combination would have yielded predictable results of improving user convenience, expanding the applicability of the design, and improving usability by offering visual energy feedback to users. Further, it would have been obvious to try combining the teachings of Botts with Chan, without requiring much effort and with a reasonable expectation of success. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by successful implementations in the field such as explained by Botts. There was a finite number of identified and predictable ways to convey energy usage information to a user, such as through numerical displays, audible alarms, or color-coded visual indicators, that were well-known and commonly used

in the field. The known benefits and feasibility of including colored indicator lights in appliances as taught by Botts would prompt the application of Botts in the same field based on design incentives and other market forces. Prior art such as Botts has successfully demonstrated that incorporating visual feedback mechanisms, including color-coded indicators, into household appliances effectively communicates operational or energy usage status to users, improving both efficiency and user awareness. Thus, there would have been a reasonable expectation of success for combining Chan and Botts to provide similar advantages within Chan's energy monitoring and control framework.

3. Claim 50: “The appliance according to claim 1, further comprising in the single enclosure a light source that emits a visible or non-visible light for illumination or indication, the non-visible light is infrared, ultraviolet, X-rays, or gamma rays, the light source is coupled to the AC connector for being powered from the AC power, and wherein the light source is coupled to the wireless transceiver for illumination or indication in response to digital data received from the wireless network.”

267. Chan-Botts discloses a light source in the *single enclosure* that emits a visible light for illumination or indication, the light source is coupled to the *AC connector* for being powered from the AC power, and wherein the light source is coupled to the *wireless transceiver* for illumination or indication in response to digital data received from the wireless network.

268. First, Chan-Botts discloses a light source that emits a visible light for illumination. Botts discloses that the appliance includes:

an indicator for simply and easily conveying the energy usage of the appliance. For example, an embodiment may include one or more *indicators* on the appliance, or on the display panel of the appliance, that show whether the appliance is operating within a predetermined energy efficient range. More particularly, the indicator may be a *green light (e.g., a green LED or symbol)* when the energy usage of the appliance is within the predetermined energy efficient range. The indicator may be a *red light (e.g., a red LED or symbol)* when the energy usage of the appliance is outside of the predetermined energy efficient range. (EX1006, 10:56-67.)

269. A POSITA would have been motivated to combine Chan's *appliance module* with Botts' conventional LED(s)/light(s) to indicate energy usage, thereby improving usability of the device with a reasonable expectation of success.

270. Second, Chan-Botts discloses the light source is housed within the *appliance module* (i.e., the *single enclosure*) and coupled to the *AC connector* for being powered from the AC power. It would have been obvious that light indicator(s) would be coupled to Chan's *AC connector* to receive power. A POSITA would have further understood that such an indicator could be readily incorporated within Chan's *appliance module*, which already houses the current sensor, first sensor, antenna, and wireless transceiver. (EX1004, [0070], Claim 1.)

Integrating the light source within this enclosure would allow it to draw power from the same AC connection and receive control signals through the existing circuitry of Chan's module, without altering its overall network or sensor configuration. This integration maintains Chan's compact architecture while enabling the added indication functionality taught by Botts.

271. Third, Chan-Botts discloses the light source is coupled to the wireless transceiver for illumination or indication in response to digital data received from the wireless network. A POSITA would have understood (and found it obvious) that, when incorporated into Chan's appliance module, Botts's indicator would be *coupled to the wireless transceiver* to illuminate or change color *in response to digital data received over the wireless network*. Chan teaches that gateway 300 communicates bidirectionally with the appliance module using "wireless signal technology" to send control or command information and to receive power-usage data measured by the module. (EX1004, [0057].)

272. A POSITA would have recognized that the gateway could transmit data such as control settings, energy-efficiency thresholds, or operational commands, and that the indicator could visually reflect this information—for example, by showing whether the measured energy usage reported from Chan's power-measure module 421 falls within a threshold range, whether a control signal from the gateway requires power reduction, or whether the appliance is about to be

turned on or off in response to a received command. Thus, the indicator would respond to digital data communicated wirelessly through the network, consistent with the claimed coupling to the wireless transceiver.

273. A POSITA would have been motivated to combine Chan and Botts and include a light source that emits visible light (*e.g.*, LED) in Chan's appliance module as taught by Botts for indication (*e.g.*, to indicate whether the energy usage of the appliance is within the predetermined energy efficient range, or to indicate whether the energy usage of the appliance exceeded settings and would be turned off automatically after a certain amount of time.)

4. Claim 51: "The appliance according to claim 50, wherein the light source is coupled to the current sensor for illumination or indication in response to the measured AC current."

274. Chan-Botts discloses the light source is coupled to the *current sensor* for illumination or indication in response to the measured AC current. A POSITA would have understood (and found it obvious) from Botts that the indicator light changes color based on the detected energy usage of the appliance (*e.g.*, turning green when the measured current indicates efficient operation and red when the current indicates higher energy consumption). (EX1006, 10:56-67; *supra* § IX.B.3.) Power is a function of current ($P = VI$), so such indication of power levels would directly correspond to the magnitude of current measured by Chan's current sensor.

275. A POSITA would have recognized that coupling the light source to Chan's *current sensor* would allow the indicator to quickly respond to real-time current measurements. This coupling would simplify the control logic and reduce processing delay. A POSITA would have understood that this local visual feedback is complementary to Chan's wireless transmission of current data. For example, the appliance module can both locally indicate current or power conditions using the light source, and simultaneously or cooperatively transmit current measurements wirelessly to the gateway or a remote server for monitoring, analysis, or control. Thus, it would have been obvious to combine Chan and Botts to include a light source coupled to the *current sensor* for illumination or indication in response to the measured AC current in Chan's appliance module.

5. Claim 52: “The appliance according to claim 50, wherein the light source consists of, or comprises, a lamp, an incandescent lamp, a gas discharge lamp, a fluorescent lamp, a Solid-State Lighting (SSL), a Light Emitting Diode (LED), an Organic LED (OLED), a polymer LED (PLED), or a laser diode.”

276. Chan-Botts discloses the light source comprises an LED. As discussed above, Botts discloses that the appliance includes “an indicator for simply and easily conveying the energy usage of the appliance.” (EX1006, 10:56-67.) Botts discloses that “the indicator may be a *green light (e.g., a green LED* or symbol) when the energy usage of the appliance is within the predetermined energy efficient range. The indicator may be a *red light (e.g., a red LED* or

symbol) when the energy usage of the appliance is outside of the predetermined energy efficient range.” *Id.* Thus, Chan-Botts discloses a light source consists of, or comprises a Light Emitting Diode (LED).

C. Ground 3: Chan in view of Scherz Renders Obvious Claims 8-11, 54, 57

1. Summary of Scherz

277. Scherz was published by at least January 9, 2007, before the earliest provisional application filing date of the ’590 patent, and thus qualifies as prior art under §102(b). (EX1030.) The Examiner never found, and Applicant never cited, Scherz during prosecution.

278. Scherz is a textbook titled “Practical Electronics for Inventors” (EX1007, Title). Scherz provides an overview of fundamental electronic components and devices, including mechanical, reed, and solid-state relays. (EX1007, 307-309.) Scherz was published by McGraw-Hill and was a widely used and well-known reference among POSITAs. A POSITA would have looked to Scherz for established knowledge of relay operation and types, and would have relied on its teachings to implement or select an appropriate relay (*e.g.*, a mechanical, reed, or solid-state relay) when implementing Chan, with a reasonable expectation of success.

279. Scherz is analogous to the field of the '590 patent. Both relate to electrical switching devices used to control current or power flow within electronic or appliance systems. (EX1001, 114:38-114:44; EX1007, 307-310.)

2. Motivation to combine Chan and Scherz

280. Chan and Scherz are analogous art to the '590 patent. Both relate to electrical switching devices and their use in controlling power or signal flow (*e.g.*, within electronic devices). (EX1004, [0070]; EX1007, 307-310.) A POSITA would have been motivated to combine Chan and Scherz to apply Scherz's teachings regarding the well-known relay types (*i.e.*, mechanical, reed, and solid-state) to implement Chan's relay switch 423 with a reasonable expectation of success. The Chan-Scherz combination would result in an appliance module in which the relay switch 423 of Chan is realized using any of the standard relay forms (*i.e.*, mechanical, reed, and solid-state) described by Scherz. A POSITA would have recognized these were interchangeable design alternatives yielding predictable results in line with their well-understood properties.

281. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by widespread and successful use of mechanical, reed, and solid-state relays across comparable electrical and appliance control applications. Prior art such as Scherz has successfully demonstrated that these relay configurations can be reliably implemented in various circuit control

systems to manage current flow, switching response, and isolation. Thus, there would have been a reasonable expectation of success for combining Chan and Scherz to achieve predictable control and switching functionality within Chan's appliance module.

3. Claim 8: “The appliance according to claim 7, wherein the electrically actuated switch is ‘normally open’ type, ‘normally closed’ type, or a changeover switch, wherein the electrically actuated switch is ‘make-before-break’ or ‘break-before-make’ type, or wherein the electrically actuated switch have two or more poles or two or more throws, and contacts of the electrically actuated switch are arranged as a Single-Pole-Double-Throw (SPDT), Double-Pole-Double-Throw (DPDT), Double-Pole-Single-Throw (DPST), or Single-Pole-Changeover (SPCO).”

282. Chan teaches the *electrically actuated switch* has two or more poles or two or more throws, and contacts of the electrically actuated switch are arranged as a Single-Pole-Double-Throw (*SPDT*) or Double-Pole-Double-Throw (*DPDT*). For example, Chan's *appliance module* includes a *relay switch 423*. (EX1004, [0070].)

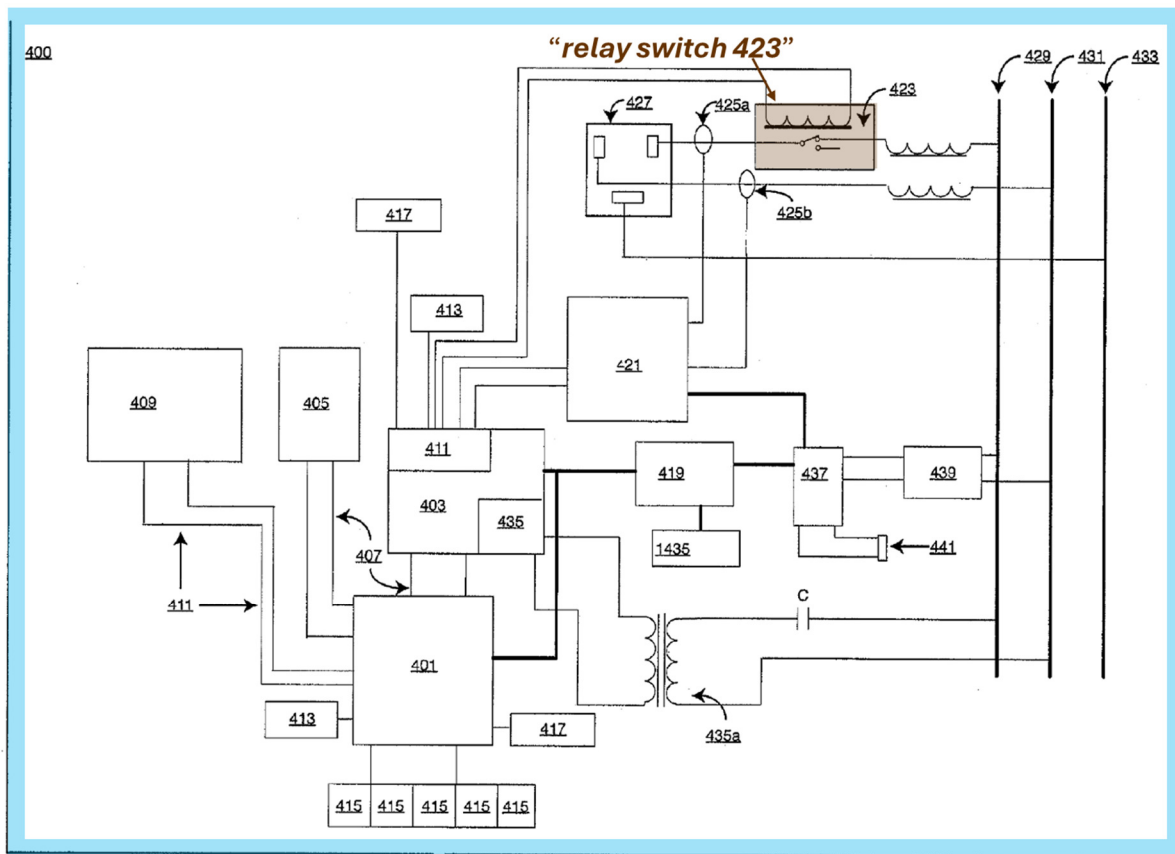


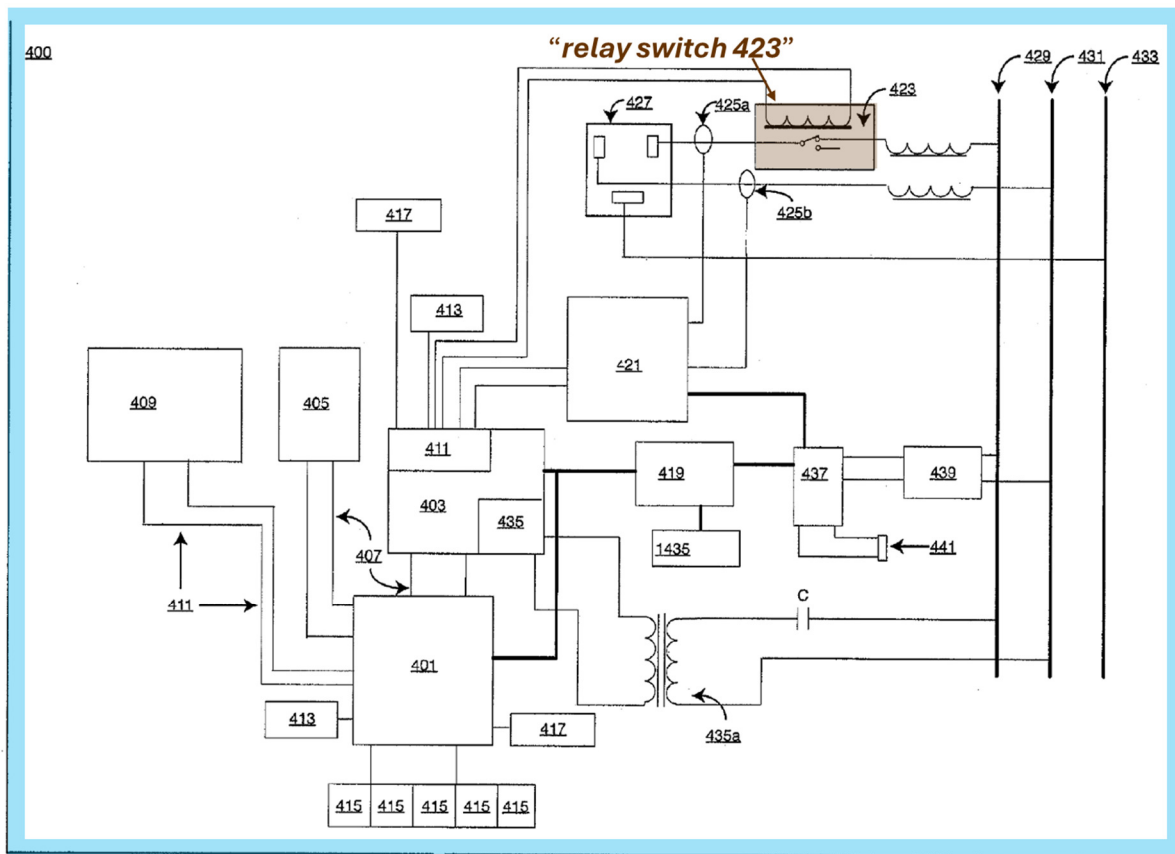
FIG. 4

283. A POSITA would have known basic design choices for relay switches include: “mechanical relays, reed relays, and solid-state relays.” (EX1007, 307.) Thus, it would have been obvious to try a mechanical relay switch since there is a limited subset of possible types of relay switches. Further, it was well-known that a “mechanical relay’s switch section comes in many of the standard manual switch arrangements (e.g., SPST, *SPDT*, *DPDT*, etc.).” (EX1007, 308; *see also*, EX1020, 116-118, 126-127.) Thus, a POSITA seeking to implement Chan’s *relay switch 423*, would have readily selected a conventional mechanical SPDT or DPDT relay configuration (having two throws and either one pole (SPDT) or two

poles (DPDT)) to achieve the desired switching functionality described by Chan. Such relays were widely available, inexpensive, and routinely used in appliance control circuits to switch AC mains or load currents. (EX1007, 307-308.) Accordingly, the selection of a mechanical relay of standard configuration (*e.g.*, *SPDT*, *DPDT*, etc.) in Chan's system would have been obvious.

4. Claim 9: “The appliance according to claim 7, wherein the electrically actuated switch is a latching or a non-latching type relay.”

284. I note that the claim requires either latching or a non-latching type relay, which encompasses all relays. Chan's *appliance module*, which includes a *relay switch 423*, thus satisfies this limitation. (EX1004, [0070].)



a POSITA implementing Chan's *relay switch 423* would have recognized that either a latching or non-latching mechanical relay could be used depending on whether it was desirable for the relay to exhibit latching behavior. Selecting between these known mechanical relay variants would have been a routine design choice yielding predictable results.

5. Claim 10: “The appliance according to claim 9, wherein the relay is a solenoid-based electromagnetic relay that is a reed relay, wherein the relay is solid-state or semiconductor based, or wherein the relay is a Solid State Relay (SSR).”

286. Chan discloses that the relay is a solenoid-based electromagnetic relay that is a reed relay, wherein the relay is solid-state or semiconductor based, or wherein the relay is a Solid State Relay (SSR). For example, Chan's *appliance module* includes a *relay switch 423*. (EX1004, [0070].)

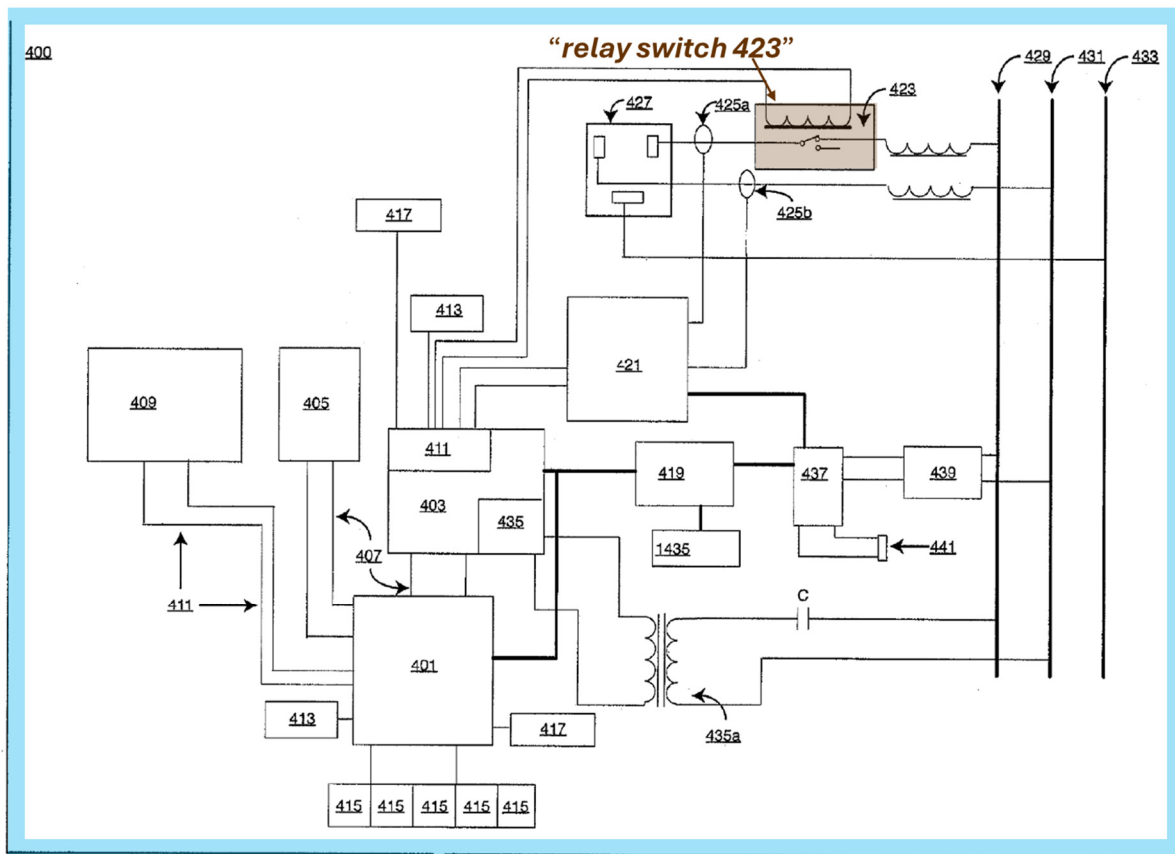


FIG. 4

287. At the time of the invention, it was well-known that relay switches came in three basic types: “mechanical relays, *reed relays*, and *solid-state relays*.” (EX1007, 307.) Thus, a POSITA looking to implement *relay switch 423* would have found it obvious to try a *reed relay switch* or a *solid-state relay switch* since there is a limited subset of possible types of relay switches. For example, “[r]eed relays consist of a pair of reeds (thin, flexible metal strips) that collapse whenever a current is sent through an *encapsulating wire coil* [i.e., a *solenoid*].” (EX1007, 307.) Further, a “solid-state relay is a device that can be made to switch states by applying external voltages across n-type and p-type *semiconductive* junctions.”

(EX1007, 307.) Thus, a POSITA looking to implement *relay switch 423* would have understood (and found it obvious) that it could be realized as (1) a solenoid-actuated mechanical relay (including a reed relay) or (2) a semiconductor-based relay such as an SSR. (EX1007, 307.) Such an implementation would have yielded predictable results consistent with the well-known operation of these relays.

6. Claim 11: “The appliance according to claim 7, wherein the electrically actuated switch is based on an electrical circuit that comprises an open collector transistor, an open drain transistor, a thyristor, a TRIAC, or an opto-isolator.”

288. Chan discloses that the relay switch is based on an electrical circuit that comprises a *thyristor* or a *TRIAC*. For example, Chan’s appliance module includes a *relay switch 423*. (EX1004, [0070].)

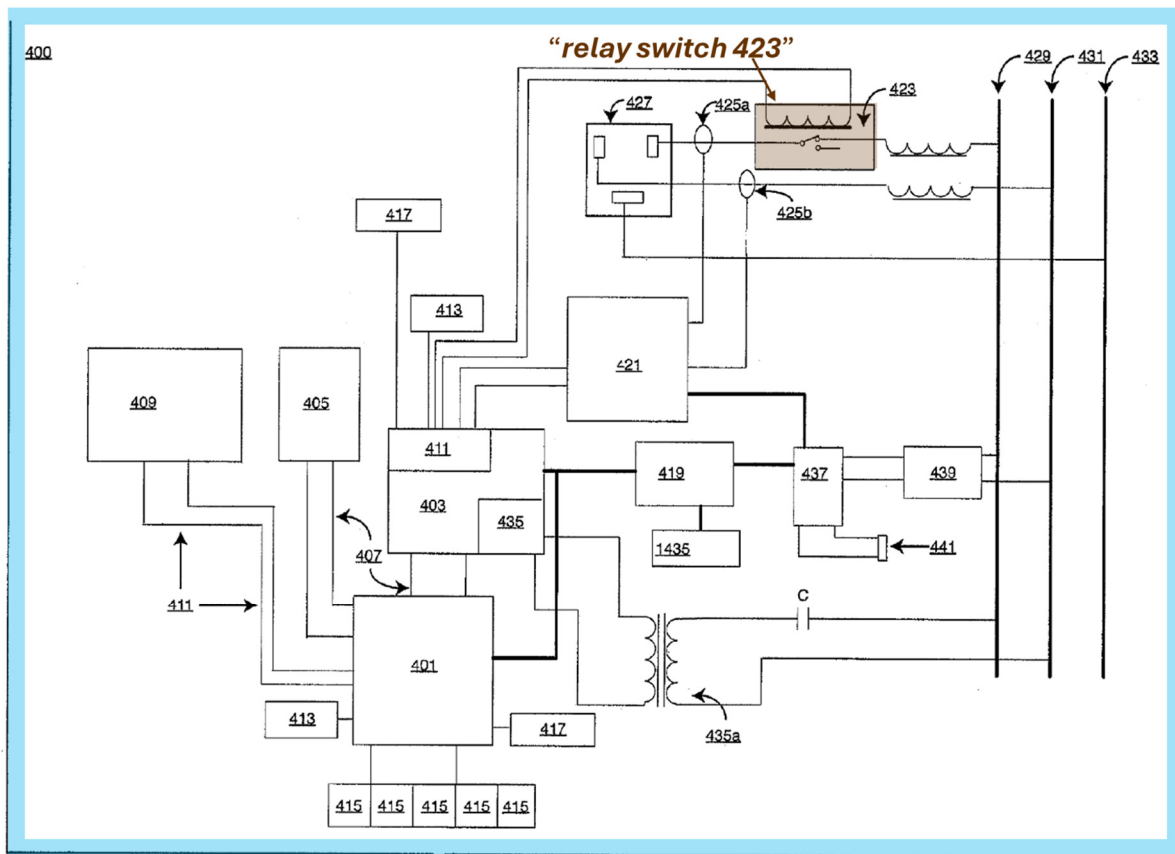


FIG. 4

289. At the time of the invention, it was well-known that *relay switches* came in three basic types: “mechanical relays, reed relays, and *solid-state relays*.” (EX1007, 307.) Thus, a POSITA looking to implement *relay switch 423* would have found it obvious to try a *solid-state relay* switch since there is a limited subset of possible types of relay switches. Solid-state relays “include transistors (FETs, BJTs) and *thyristors* (SCRs, *triacs*, diacs, etc.).” (EX1007, 309.) Thus, a POSITA looking to implement *relay switch 423* would have understood (and found it obvious) that it could be realized as a semiconductor-based relay such as an SSR including a *thyristor* or a *TRIAC*. (EX1007, 307.) Such an implementation would

have yielded predictable results consistent with the well-known operation of these relays.

7. **Claim 54:** “The appliance according to claim 53, wherein the actuator consists of, or comprises, a motion actuator that causes a linear or rotary motion, and the appliance further comprising a conversion mechanism for respectfully converting to rotary or linear motion based on a screw, a wheel and axle, or a cam.”

290. As described above, *relay switch 423* is an actuator. (*Supra*, IX.A.13.) *Relay switch 423* is a motion actuator.

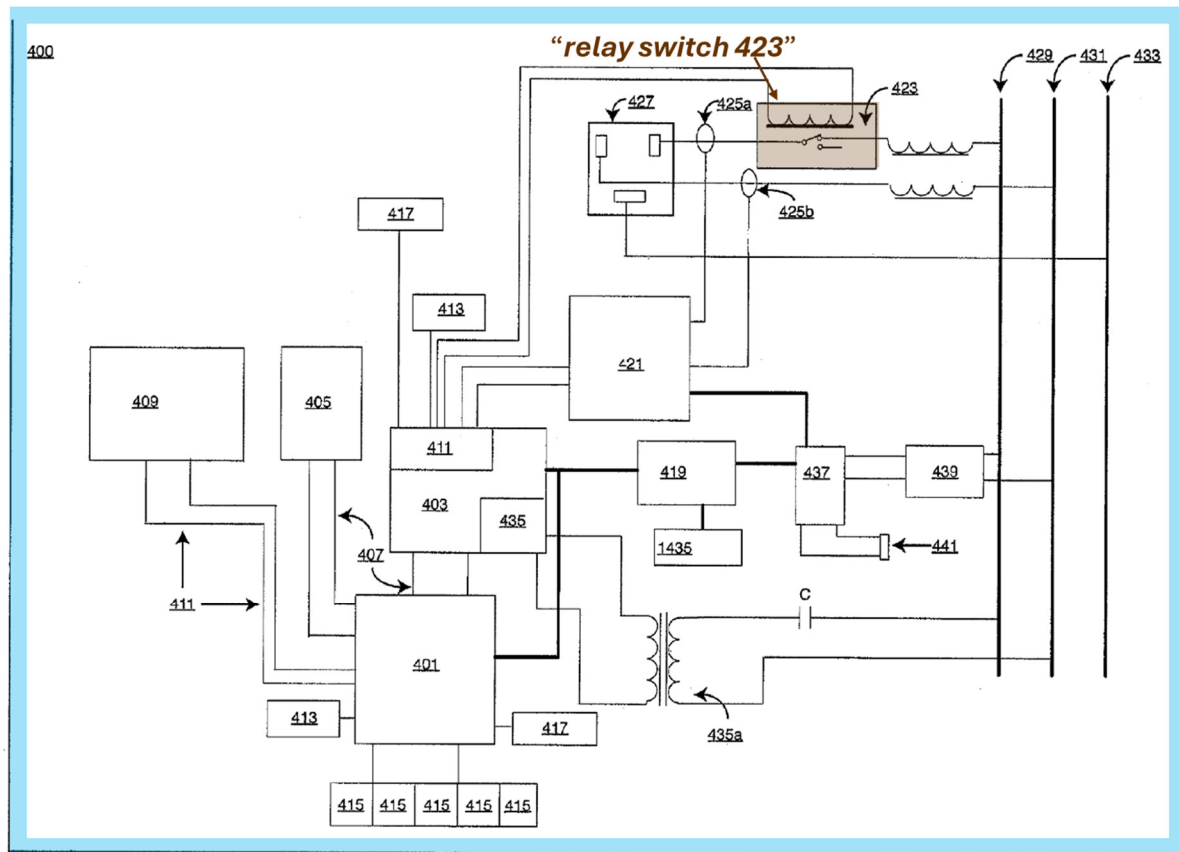


FIG. 4

291. Chan's *relay 423* is an electrically actuated switch that changes state in response to a control signal received via the ZigBee wireless transceiver, as discussed above.

292. The '590 patent itself confirms that a relay is a form of *electromechanical actuator* that produces motion. It explains that "a relay is a non-limiting example of an electrically operated switch" that includes "a solenoid operating a ratchet and cam mechanism," or opposing coils with an over-center spring or permanent magnet to move the armature and contacts. (EX1001, 113:14-34.) Thus, when energized, the solenoid produces *linear motion* of the armature, and mechanisms such as springs or cams that *convert that linear displacement into rotary motion* of the contact assembly.

293. As Scherz explains, relays were well-known to come in *three basic types*—mechanical, reed, and solid-state—each performing the same switching function with differing mechanisms. (EX1007, 307-308.) Scherz describes that in a *mechanical relay*, "a current sent through a coil magnet acts to pull a flexible, spring-loaded conductive plate from one switch contact to another." (EX1007, 307-308.) As shown in Scherz, the relay switch operates through a cam mechanism that converts the linear motion of the actuator or plunger (*e.g.*, driven by a spring) into rotary motion of the moving contact arm to open or close the circuit.

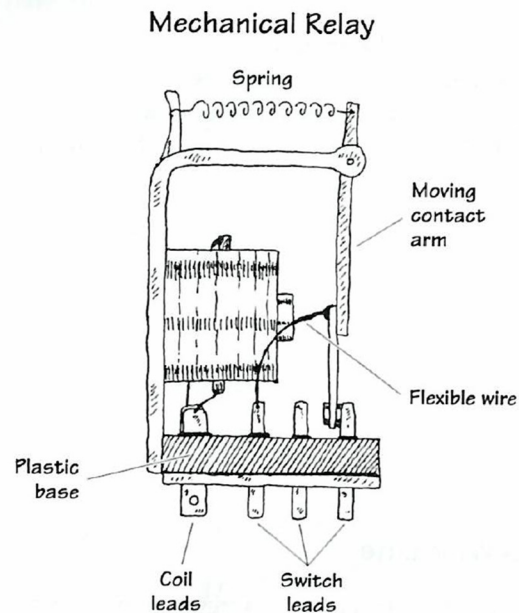


FIGURE 3.42

294. When looking to implement Chan's *relay switch 423*, A POSITA would have recognized that all three relay types were well understood and interchangeable depending on the desired application, and that choosing a *mechanical relay* would have been obvious to try among a finite set of predictable options.

295. Thus, a POSITA would have understood (and found it obvious) that *relay switch 423* operates as an electromechanical actuator: when the coil is energized, it generates a magnetic force that moves the armature to open or close the contacts. In a latching configuration, the relay may employ a cam, spring, or ratchet mechanism that converts or extends the armature's movement into a bistable or maintained position, allowing the relay to retain its state when power is

removed. Thus, *relay switch 423* converts linear motion (*e.g.*, of the spring) to rotary motion (*e.g.*, of the moving contact arm) based on the cam.

8. Claim 57: “The appliance according to claim 53, wherein the actuator consists of, or comprises, an electrical signal generator.”

296. As described above, *relay switch 423* is an actuator. (*Supra*, IX.A.13.) *Relay switch 423* is also an actuator comprising an electrical signal generator.

297. A POSITA would have understood (and found it obvious) that Chan’s relay switch 423 would be implemented as a mechanical electromagnetic relay, the standard type used for switching AC power in household appliances. As explained by Scherz, “for a typical mechanical relay, a current sent through a coil magnet acts to pull a flexible, spring-loaded conductive plate from one switch contact to another.” (EX1007, 307.) Mechanical relays were well-known, commercially available components for switching AC circuits, and were one of only a finite number of predictable relay configurations (*e.g.*, mechanical relays, reed relays, and solid state relays) available to a POSITA. (EX1007, 307.) Accordingly, it would have been obvious to implement Chan’s relay switch 423 as a mechanical relay.

298. When a mechanical relay’s coil is energized or de-energized, the change in current through the magnetic coil generates a varying electromagnetic

field. (EX1007, 308.) As explained by Scherz, “the coil of a relay acts as an inductor,” and when current flow is suddenly interrupted “the coil will respond by producing a sudden, very large voltage (*i.e.*, “electrical signal”) across its leads, causing a large surge of current through it.” (EX1007, 310.) Scherz further explains that this surge “is a result of a collapsing magnetic field within the coil as the current is terminated abruptly,” and that such surges “can create menacing voltage spikes (as high as 1000 V).” (EX1007, 310.)

299. A POSITA would have recognized that this inductive behavior constitutes electrical signal generation: energizing or de-energizing the relay coil produces a transient voltage pulse (an electrical signal) generated by the relay switch itself. The induced voltage represents an electrical output signal produced by the relay switch’s changing magnetic field. Accordingly, Chan’s *relay switch 423* is an electrical signal generator.

D. Ground 4: Chan in view of Middelhoek Render Obvious Claims 12, 14, 17, 18

1. Summary of Middelhoek

300. Middelhoek was published by at least June 30, 1999, before the earliest provisional application filing date of the ’590 patent, and thus qualifies as prior art under §102(b). (EX1031.) The Examiner never found, and Applicant never cited, Middelhoek during prosecution.

301. Middelhoek is a textbook titled “Handbook of Sensors and Actuators: Measuring Current, Voltage and Power.” (EX1008, Title). Middelhoek provides an overview of fundamental electronic components and devices for sensing voltages and currents, including galvanometer, wattmeter, or bolometer. (EX1008, vii, 1, 154.) Middelhoek was published by Elsevier. A POSITA would have looked to Middelhoek for knowledge about current and power sensors when implementing Chan. For example, a POSITA would have looked to Middelhoek for “state-of-the art developments in both the applied and theoretical fields of sensors and actuators” for methods to sense voltages and currents, and measure electrical power and energy, and would have relied on its teachings to implement or select the appropriate instrumentations for energy measurement and sensing when implementing Chan, with a reasonable expectation of success. (EX1008, vii.)

302. Middelhoek is analogous to the field of the ’590 patent. Both relate to sensors and instrumentation for measuring electrical current, voltage, and power in appliance and electronic systems. (EX1001, 81:60-82:54, 84:29-40; EX1008, Title, 1, 29, 123-126, 141-159.)

2. Motivation to combine Chan and Middelhoek

303. Chan and Middelhoek are analogous art to the ’590 patent. Both relate to current sensors and their use in measuring current, voltage, and power

(*e.g.*, within electronic devices). (EX1004, [0070]; EX1008, Title, 1, 29, 123-126, 141-159.) Middelhoek provides an overview on “recent methods to sense voltages and currents,” and “instance electrical power and energy measurements.” (EX1008, vii.) Middelhoek specifically states that its teachings “illustrate commonly employed techniques,” “cover[ing] patent literature aimed at industrial applications,” and “state-of-the-art developments in both the applied and theoretical fields of sensors and actuators.” (EX1008, vii.) Thus, both Chan and Middelhoek are from the same field of endeavor, and all relate to the same technical problems of operating current sensors and instrumentations for measuring power and energy. Thus, a POSITA would have been motivated to combine Chan and Middelhoek to apply Middelhoek’s teachings regarding the well-known current sensors and wattmeter types (*i.e.*, galvanometer, non-contact current meter) and methods for power and energy measurement (*i.e.*, sensing current and voltage separately and multiplying, and measuring single or multi-phase AC power) to implement Chan’s CT 425a and/or power measure module 421.

304. It would have been obvious to a POSITA to apply Middelhoek’s teachings related to conventional electrical components to Chan, as various current sensor and wattmeter features can improve Chan’s current sensors in the same way and yield predictable results. The known benefits of various features would prompt the application of Middelhoek in the same field based on design incentives

and market forces. Further, it would have been obvious to try combining Middelhoek with the teachings of Chan, for example by using contactless current sensors and sensors that comprises a galvanometer, without requiring much effort and with a reasonable expectation of success. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by successful implementations in the field. There was a finite number of types and ways to implement current sensors, that were commonly known in the industry and easy to manufacture and integrate into Chan. Prior art such as Middelhoek has successfully demonstrated that conventional current and voltage sensing techniques (*e.g.*, galvanometric, non-contact, and multi-phase AC measurement methods) can be implemented across a range of power monitoring systems. These techniques were well understood, commercially proven, and routinely adopted to improve measurement precision and circuit safety. Thus, there would have been a reasonable expectation of success for combining Chan and Middelhoek to achieve reliable and accurate power measurement functionality within Chan's appliance module.

3. Claim 12: “The appliance according to claim 1, wherein the current sensor comprises an ampermeter, galvanometer, or a hot-wire ampermeter.”

305. As discussed, Chan discloses its appliance comprises a current sensor. For example, Chan discloses that *appliance module 400* includes *a power measure*

module 421, which “is connected to a power supply 437 and two (2) *current transformers (CT) 425a* and 425b that are connected to *a standard AC socket 427*.” (*Supra* § IX.A.2.e; EX1004, [0070].)

306. In 2012, it was well-known that current sensors could be implemented using a variety of equivalent configurations, including ammeters [*e.g.*, ampermeters], *galvanometers*, or hot-wire ammeters. For example, Middelhoek discloses that “[t]o measure voltages or currents one usually exploits observable effects related to these variables (*e.g.*, the deflection of the needle of a *galvanometer*). *Galvanometers* date from the discovery of the interaction between an electric current and a magnetic needle by Oersted in 1819. *Galvanometers* made accurate analogue current measures possible.” (EX1008, 1.)

307. A POSITA would have understood (and found it obvious) that galvanometers were among a *finite number of predictable sensor types* that convert electrical current into a measurable quantity (mechanical deflection or electrical signal) and could readily be used to perform Chan’s current-sensing function. Such configuration was well-known, dating as far as back to 1819, and routinely used to measure voltages or currents. (EX1008, 1.) Accordingly, the selection of a current sensor of a standard configuration comprising a galvanometer in Chan’s system would have been an obvious design choice and yielding predictable results.

308. A POSITA would have understood (and found it obvious) that a *current transformer* and a *galvanometer* perform the same fundamental function—producing a measurable output proportional to current flow—and that both were standard, commercially available current-measurement devices. Selecting a galvanometer to implement Chan’s current-sensing function would therefore have been *an obvious substitution of one known sensor type for another* to achieve predictable current measurement results.

309. Accordingly, it would have been obvious to implement Chan’s current sensor using a standard configuration comprising a galvanometer, since it performs the same current-measurement function with predictable results. The selection of such a conventional sensor design—well established for nearly two centuries—would have been obvious to try and would have yielded predictable and reliable operation.

4. Claim 17: “The appliance according to claim 15, wherein the wattmeter comprises a bolometer, or wherein the wattmeter accumulates or averages readings.”

310. Chan discloses that its appliance includes a wattmeter that measures and reports the energy usage of the connected appliance, implemented through power measure module 421 and its associated current transformers 425a and 425b. (EX1004, [0070]-[0071].) A POSITA would have understood (and found it obvious) that the power measure module 421 accumulates or averages readings.

311. In 2012, “averaging wattmeters,” such as electro dynamometers and thermal multipliers, were well-known and commonly used for measuring electrical power. (EX1008, 154.) Middelhoek provides an overview of electro dynamometers. “If one replaces the permanent magnet in a moving coil instrument (d’Arsonval) with coil(s), *i.e.* . an electromagnet, one gets an electro dynamometer.” (EX1008, 148.) Middelhoek further discloses that electro dynamometers are explained in further detail in “standard textbooks” and that “[i]t is a most commonly used wattmeter.” *Id.*

312. A POSITA looking to implement Chan’s power measure module 421 would have found it obvious to try an *averaging wattmeter*, such as an *electrodynamometer*, because such instruments were commonly used for accurately measuring average power consumption over time. (EX1008, 148, 154.)

5. Claim 18: “The appliance according to claim 15, wherein the wattmeter comprises the current sensor, or wherein the wattmeter is based on multiplying a measured voltage and the current measured by the current sensor.”

313. As discussed above, Chan discloses that its appliance includes a *power measure module 421* that determines the energy usage of the connected appliance. Chan explains that the *power measure module 421* “is connected to a power supply 437 and *two (2) current transformers (CT) 425a and 425b* that are connected to a standard AC socket 427.” (EX1004, [0070]; *supra* § IX.A.2.e.) **CT**

425a is the current sensor that detects the alternating current consumed by the appliance and provides input signals to the power measure module, which processes those signals to determine power consumption.

314. A POSITA would have understood (and found it obvious) that a wattmeter is a meter measuring “power,” and watts are the measurement unit for “the product of current and voltage.” (EX1008, 123.) It was common knowledge that a wattmeter is based on multiplying a measured voltage and measured current. It thus follows that “power” is sensed “indirectly via combined current and voltage measurement” and “standard methods for measuring power” include “measuring current and voltage separately, and multiplying the values.” (EX1008, 123, 126.) For example, Middelhoek discloses “a simple design using an inductive current sensor and a capacitive voltage sensor,” as well as a method where “a thermoelectric sensor measures the effective current, I , which is then multiplied by the effective voltage V and the power factor ϕ to establish the active power P . (EX1008, 141.)

315. Although Chan primarily describes measuring current via **current transformer 425a**, a POSITA would have understood (and found it obvious) that because the **power measure module 421** is physically connected between the appliance and the AC wall outlet, it is exposed to the line voltage and could readily measure or sample that voltage using any standard voltage-sensing circuit (*e.g.*, a

voltage divider or capacitive sensor). Combining that voltage information with the measured current values from *current transformer 425a* would allow the power measure module 421 to determine power as the product of voltage and current, consistent with the standard wattmeter implementations described by Middelhoek. Thus, a POSITA would have recognized that Chan's wattmeter effectively comprises the current sensor and operates based on multiplying measured voltage and current.

**E. Ground 5: Chan in view of Goldsmith Render Obvious
Claims 28, 31**

1. Summary of Goldsmith

316. Goldsmith was published by at least January 20, 2006, before the earliest provisional application filing date of the '590 patent, and thus qualifies as prior art under §102(b). (EX1009.) The Examiner never found, and Applicant never cited, Goldsmith during prosecution.

317. Goldsmith is a textbook titled "Wireless Communications." (EX1009, Title.) Goldsmith provides an overview of wireless communication techniques, including the wireless systems available at the time of publication in 2005.

318. Goldsmith discloses that the wireless systems available in 2005 includes, cellular telephone systems, cordless phones, wireless LANs, wide area wireless data services, broadband wireless access, paging systems, satellite

networks, low-cost low-power radios such as Bluetooth and Zigbee, as well as ultrawideband radios. (EX1009, xvii, 1-24, 595-603.)

319. Goldsmith discloses the wireless LAN standard, IEEE 802.11b standard, the standard which many companies developed their products on, and that “[t]wo additional standards in the 802.11 family were developed to provide higher data rates than 802.11b. The *IEEE 802.11a wireless LAN* standard . . . the other standard, *802.11g*.” (EX1009, 16.)

320. Goldsmith discloses that both Bluetooth, and 802.11b WLAN are ISM Band II frequencies. (EX1009, 18-23.)

Table 1.2: Unlicensed U.S. spectrum allocations	
Band	Frequency
ISM band I (cordless phones, 1G WLANs)	902–928 MHz
ISM band II (Bluetooth, 802.11b and 802.11g WLANs)	2.4–2.4835 GHz
ISM band III (wireless PBX)	5.725–5.85 GHz
U-NII band I (indoor systems, 802.11a WLANs)	5.15–5.25 GHz
U-NII band II (short-range outdoor systems, 802.11a WLANs)	5.25–5.35 GHz
U-NII band III (long-range outdoor systems, 802.11a WLANs)	5.725–5.825 GHz

321. Goldsmith discloses that “*WiMAX* is an emerging *broadband wireless technology* based on the IEEE 802.16 standard [20, 21]. The core 802.16 specification is a standard for broadband wireless access systems operating at radio frequencies between 10 GHz and 66 GHz.” (EX1009, 17, 601.)

322. Further, Goldsmith discloses the 3G cellular system, GSM (Global Systems for Mobile Communications), and EDGE (Enhanced Data Services for

GSM Evolution). “*The GSM standard* uses a combination of TDMA and slow frequency hopping with frequency-shift keying for the voice modulation,” “the *third generation (3G) cellular systems are based on a wideband CDMA standard*,” and “*Enhanced Data Services for GSM Evolution (EDGE)*, further increases data rates using a high-level modulation format combined with FEC coding.” (EX1009, 12-13, 596.) “*W-CDMA* is the primary competing 3G standard to cdma2000. It has been selected as the *3G successor to GSM*, and in this context is referred to as the *Universal Mobile Telecommunications System (UMTS)*.” (EX1009, 600; *see also Id.* Table D.4.)

Table D.4: 3G digital cellular phone standards							
Parameter	cdma2000				W-CDMA		
	1X	1XEV-DO	1XEV-DV	3X	UMTS	FOMA	J-phone
Channel bandwidth (MHz)	1.25	1.25	1.25	3.75	5	5	5
Chip rate (Mchips/s)	1.2288	1.2288	1.2288	3.6864	3.84	3.84	3.84
Peak data rate (Mbps)	.144	2.4	4.8	5–8	2.4 ^a	2.4 ^a	2.4 ^a
Modulation	QPSK/MPSK (DL), BPSK/QPSK (UL)				QPSK (DL), BPSK (UL)		
Coding	Convolutional (low rate), Turbo (high rate)						
Power control (Hz)	800	800	800	800	1500	1500	1500

^a 8–10 Mbps with HSDPA.

323. Goldsmith is a textbook published by Cambridge University Press and authored by Andrea Goldsmith, a professor of Electrical Engineering at the Stanford University. A POSITA would have looked to Goldsmith for wireless communication systems, protocols, and techniques of applying them.

324. Goldsmith is analogous to the field of the '590 patent. Both relate to wireless communication techniques for connecting electronic devices and components over different types of wireless networks. (EX1001, 4:2-6:26, 45:15-67, 62:34-65; EX1009, xvii, 1-24, 595-603.)

2. Motivation to combine Chan and Goldsmith

325. Chan and Goldsmith are analogous art to the '590 patent. Both relate to wireless communication techniques for connecting electronic devices/components over different types of wireless networks. Chan discloses its appliance module may communicate using “a wireless RF signal” or “*other wireless technologies, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media*” and its system comprises “one or more communication ports being configured for at least one format selected from *GSM, Cellular, Fiber, Coaxial, Ethernet, Zig-bee, RS232, RS485, M-bus, USB, Firewire, 802.XXX, WiLan, WiMax, Powerline, HomePNA, and MOCA.*” (EX1004, [0070], [0073], Claim 2.) Chan expressly recognizes that multiple wireless standards are used for its appliance module communications. Goldsmith provides a comprehensive overview of the various wireless systems and networking techniques available at 2005, including broadband wireless network, satellite network, WiMax, GSM, and 3G cellular systems in a chapter titled “1.4 Current Wireless Systems.” (EX1009, 8-21.) Thus, both references are from the same field of endeavor and are

reasonably pertinent to the same technical problem of providing reliable and flexible wireless communication between devices/appliances and networks.

326. It would have been obvious for a POSITA to look to Goldsmith for conventional wireless networking techniques and protocols that can be applied to Chan's system, which expressly recognized communication via multiple wireless technologies. (EX1004, [0070], [0073], Claim 2.) Goldsmith explains the underlying principles, frequency bands, modulation techniques, and considerations of adopting wireless systems such as WLAN (IEEE 802.11), WiMax (IEEE 802.16), broadband wireless network, satellite network, and cellular systems (3G, GSM), and therefore provides implementation details and/or design options to a POSITA for implementing Chan. A POSITA would have recognized that the wireless transceiver and antenna of Chan's appliance module could be implemented using any of these standard wireless protocols disclosed by Goldsmith, such as WiFi (WLAN), WiMAX, satellite networks, or cellular (3G/GSM), depending on desired range, data rate, or coverage area.

327. Further, it would have been obvious to try combining the teachings of Chan and Goldsmith, as there were a finite number of identified and predictable wireless networking technologies, such as Bluetooth, ZigBee, WiFi, WiMax, satellite, GSM, 3G, some of which are expressly disclosed in Chan, that were well-known and commercially established at that time. A POSITA would have had a

reasonable expectation of success in applying Goldsmith's teachings of known wireless protocols to Chan's appliance module for communication, since communication via these wireless protocols were routine and well-known in the field. The known benefits and feasibility of employing such standardized wireless technologies, as taught by Goldsmith, would have prompted their application in Chan's system based on common design incentives and market trends.

328. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by widespread and successful implementations of standardized wireless protocols in consumer and industrial communication devices during the relevant time period. Prior art such as Goldsmith has successfully demonstrated that standardized systems (*e.g.*, IEEE 802.11 (WiFi), IEEE 802.16 (WiMAX), GSM, and 3G cellular) can be reliably integrated to enable robust, interoperable, and scalable wireless communication across diverse device platforms. A POSITA would have had a reasonable expectation of success integrating these standardized systems, motivated by known benefits such as improved compatibility, scalability, and performance. Thus, there would have been a reasonable expectation of success for combining Chan and Goldsmith to achieve reliable wireless connectivity within Chan's appliance network.

3. Claim 28: “The appliance according to claim 1, wherein the wireless network is a satellite network, the antenna is a satellite antenna, and the wireless transceiver is a satellite modem.”

329. Chan-Goldsmith discloses the wireless network is a satellite network, the antenna is a satellite antenna, and the wireless transceiver is a satellite modem.

330. First, Chan-Goldsmith discloses the wireless network is a satellite network. For example, Chan’s *appliance module 400* communicates using “a wireless RF signal” or “*other wireless technologies*, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or *other media*,” thereby expressly recognizing that multiple wireless standards are used for appliance module communications. (EX1004, [0070], [0073].)

331. Goldsmith discloses that the wireless systems available in 2005 include *satellite networks*. (EX1009, 18-19.) “Commercial satellite systems are another major component of the wireless communications infrastructure” and “the Globalstar LEO system, which currently provides voice and data services over a wide coverage area at data rates under 10 kbps.” (EX1009, 18-19.)

332. It would have been obvious to a POSITA that “satellite networks,” a form of popular wireless communication system available in 2005, would be implemented in Chan. Integrating satellite communication functionality into the *appliance module* would enable operation in remote or rural areas without broadband or cellular coverage. (EX1009, 18-19.) Satellite links were well-

established, commercially available, and compatible with standard networking protocols. (EX1009, 18-19.) Moreover, incorporating satellite connectivity would allow communication with the gateway or control server regardless of local network availability. (EX1009, 18-19.) Thus, a POSITA would have found it obvious to use “satellite networks,” a form of popular wireless communication system available in 2005 when implementing Chan.

333. Chan-Goldsmith also discloses the antenna is a satellite antenna, and the wireless transceiver is a satellite modem. It was well-known that wireless communication utilizes “a *transmitter* (*transmitter electronics* plus *antenna*) generating (electromagnetic) signals” and “a *receiver* (*receiving electronics* plus *antenna*.” (EX1018, 369.) Thus, a POSITA would have understood (and found it obvious) that communication via the satellite network would utilize a satellite antenna and a satellite modem (acting as a satellite transceiver).

4. Claim 31: “The appliance according to claim 30, wherein the cellular telephone network is a Third Generation (3G) network that uses Universal Mobile Telecommunications System (UMTS), Wideband Code Division Multiple Access (W-CDMA) UMTS, High Speed Packet Access (HSPA), UMTS Time-Division Duplexing (TDD), CDMA2000 1×RTT, Evolution-Data Optimized (EV-DO), or Global System for Mobile communications (GSM), Enhanced Data rates for GSM Evolution (EDGE) EDGE-Evolution, or wherein the cellular telephone network is a Fourth Generation (4G) network that uses Evolved High Speed Packet Access (HSPA+), Mobile Worldwide Interoperability for Microwave Access (WiMAX), Long-Term Evolution (LTE), LTE-Advanced, Mobile Broadband Wireless Access (MBWA), or is based on IEEE 802.20-2008.”

334. As discussed, Chan discloses that its appliance communicates via a cellular network. For example, Chan discloses its *appliance module 400* communicates using “*other wireless technologies*” including “format[s] selected from *GSM, Cellular*.” (EX1004, [0070], [0073], Claim 2.)

335. Further, Goldsmith discloses 3G, the third-generation cellular network, GSM (Global System for Mobile Communications), and EDGE (Enhanced Data rates for GSM Evolution) as conventional cellular network communication protocols at the time of the invention. (EX1009, 8-13.)

336. Goldsmith discloses that “the *third generation (3G) cellular systems are based on a wideband CDMA standard* developed within the auspices of the International Telecommunications Union (ITU). The standard, initially called International Mobile Telecommunications 2000 (IMT-2000), provides different data rates depending on mobility and location, from 384 Kbps for pedestrian use to 144 Kbps for vehicular use to 2 Mbps for indoor office use.” (EX1009, 13.)

337. Further, Goldsmith discloses the details of GSM (Global Systems for Mobile Communications). “Many of the first generation cellular systems in Europe were incompatible, and the Europeans quickly converged on a uniform standard for second generation (2G) digital systems called GSM. The GSM standard uses a combination of TDMA and slow frequency hopping with frequency-shift keying for the voice modulation.” (EX1009, 12.)

338. Goldsmith discloses an enhancement to GSM called EDGE. “A more fundamental enhancement, *Enhanced Data Services for GSM Evolution (EDGE)*, further increases data rates using a high-level modulation format combined with FEC coding. This modulation is more sensitive to fading effects, and EDGE uses adaptive techniques to mitigate this problem. Specifically, EDGE defines six different modulation and coding combinations, each optimized to a different value of received SNR. The received SNR is measured at the receiver and fed back to the transmitter, and the best modulation and coding combination for this SNR value is used. The IS-54 and IS-136 systems currently provide data rates of 40-60 Kbps by aggregating time slots and using high-level modulation. This evolution of the IS-136 standard is called IS-136HS (high-speed). The IS-95 systems support higher data using a time-division technique called high data rate (HDR).” (EX1009, 12-13.)

339. In addition, Goldsmith also discloses usage of W-CDMA as a 3G standard and that it is referred to as the Universal Mobile Telecommunications System (UMTS). “*W-CDMA* is the primary competing 3G standard to cdma2000. It has been selected as the *3G successor to GSM*, and in this context is referred to as the *Universal Mobile Telecommunications System (UMTS)*. W-CDMA is also used in the Japanese FOMA and J-Phone 3G systems.” (EX1009, 600.)

Table D.4: 3G digital cellular phone standards							
Parameter	cdma2000				W-CDMA		
	1X	1XEV-DO	1XEV-DV	3X	UMTS	FOMA	J-phone
Channel bandwidth (MHz)	1.25	1.25	1.25	3.75	5	5	5
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Peak data rate (Mbps)	.144	2.4	4.8	5–8	2.4 ^a	2.4 ^a	2.4 ^a
Modulation	QPSK/MPSK (DL), BPSK/QPSK (UL)				QPSK (DL), BPSK (UL)		
Coding	Convolutional (low rate), Turbo (high rate)						
Power control (Hz)	800	800	800	800	1500	1500	1500

^a 8–10 Mbps with HSDPA.

340. At the time of the invention, home appliances with cellular connectivity were known. For example, a patent application filed on March 8, 2006 discloses “a receiver configured to receive a signal from a wide-area wireless communication system comprising a plurality of transmitters configured to redundantly broadcast one or more wireless signals,” “the receiver and said processor are embedded within the appliance,” “the appliance is an air conditioner or heater regulated by a thermostat, a clothes dryer, a refrigerator, a freezer, or a dishwasher,” and “the one or more wireless signals is any of an *analog cellular signal, a digital cellular signal*, a general packet radio service signal, an *enhanced data rate for GSM evolution (EDGE) service signal*.” (EX1024, Claims 14-16, 18.)

341. A POSITA would have found it obvious to use 3G networks such as W-CDMA or EDGE when implementing Chan’s cellular communication.

F. Ground 6: Chan in view of Rossing Render Obvious Claims 33, 48, 49, 55, and 56

1. Summary of Rossing

342. Rossing was published by at least July 23, 2007, before the earliest provisional application filing date of the '590 patent, and thus qualifies as prior art under §102(b). (EX1032.) The Examiner never found, and Applicant never cited, Rossing during prosecution. Rossing is a textbook relating to “Audio and Electroacoustics.” (EX1010.) Rossing discloses how conventional microphones and speakers operate.

343. Rossing discloses how a conventional microphone operates. Rossing states that “[c]ommon to virtually all microphones ever made is a diaphragm. Most microphones do not directly sense the instantaneous pressure deviations of an airborne acoustic wave. Instead, the *sound waves impinging on a diaphragm cause movement of the diaphragm*, and it is *this movement that is sensed and converted to an electrical audio signal.*” (EX1010, 757.)

344. Rossing also discloses different types of microphones such as a condenser, an electret, a dynamic, a ribbon, a carbon, or a piezoelectric microphone. “Two types of microphones avoid any mechanical attachment to the diaphragm: the *ribbon microphone* and the *condenser microphone*. A popular variant of the *dynamic microphone*, the ribbon microphone, uses a thin metal ribbon diaphragm suspended in a magnetic field.” (EX1010, 758.) “A popular

modern variant is the electret condenser microphone, perfected in 1962 by Sessler and West of Bell Laboratories.” (EX1010, 759.)

345. Rossing discloses additionally, the piezoelectric microphones and carbon microphones. (EX1010, 758.)

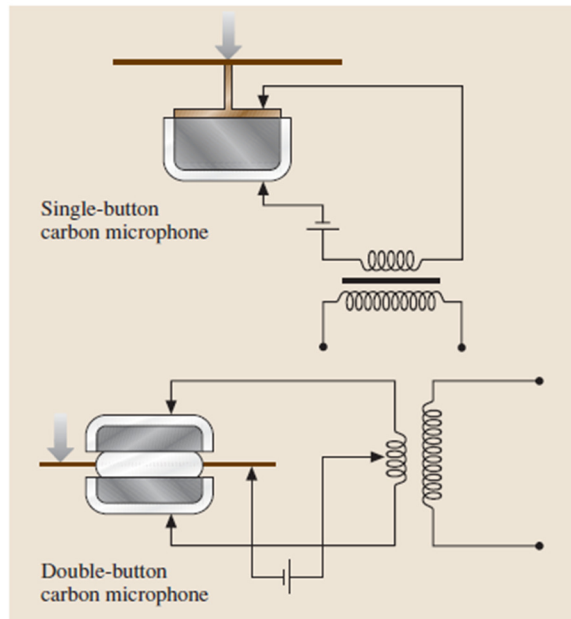


Fig. 18.11 A carbon microphone (After [18.25])

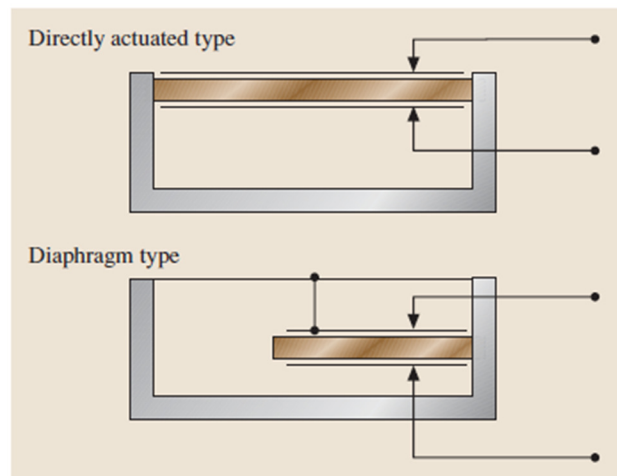


Fig. 18.12 Piezoelectric microphones (After [18.29])

346. Rossing also discloses how a conventional speaker operates. Rossing discloses that “in a manner reminiscent of microphones, few loudspeakers convert directly between electrical and acoustical energy. Instead, the *electrical energy is converted to mechanical energy, specifically the movement of a diaphragm*, often cone-shaped or dome-shaped, which then radiates acoustical energy, sometimes aided by an acoustical coupling horn or lens.” (EX1010, 763.) “In the low-frequency range, the *linear motion of an electrodynamic loudspeaker*, for

example, can be described by a single-degree-of-freedom oscillator.” (EX1010, 903.)

347. Rossing discloses that the soundwaves outputted by speakers are omnidirectional. “*Sound radiates from a loudspeaker in all directions*, depending on angle and frequency,” and that “it is rare for a speaker to have truly constant directionality across its entire pass-band, in part from that fact that most are at least somewhat directional at mid and high frequencies, and, because of the long wavelengths involved, almost unavoidably *omni-directional at low frequencies*.” (EX1010, 765.)

348. Further, Rossing discloses that there are different types of speakers including electromagnetic, piezoelectric, and electrostatic. “Many of the same transduction methods that have been used in microphones have at least been tried for loudspeakers including *magnetic (also known as dynamic)*, *piezoelectric*, and condenser.” (EX1010, 763.)

349. Rossing is a textbook published by Springer. A POSITA would have looked to Rossing for detailed specifics and techniques of using microphones and speakers in Chan.

350. Rossing is analogous to the field of the ’590 patent. Both relate to electroacoustic components, including microphones and speakers used for

capturing and generating audio signals. (EX1001, 63:14-50, 105:60-106:61; EX1010, 757-758, 763, 765, 903.)

2. Motivation to combine Chan and Rossing

351. Chan discloses its “appliance module compris[es] one or more microphones.” (EX1004, Claim 10.) As discussed, Rossing is a textbook providing basic information on how microphones and speakers operate. (EX1010, 757-758, 763, 765, 903.) Thus, Chan and Rossing are analogous art to the ’590 patent, from the same field of endeavor, and all relate to the same technical problems of operating microphone(s) and speaker(s). Thus, a POSITA would have been motivated to look to Rossing to implement Chan’s audio parts.

352. It would have been obvious to a POSITA to apply Rossing’s teachings related to conventional components to Chan, as various microphone features can improve Chan’s microphones in the same way and yield predictable results. The known benefits of various features would prompt the application of Rossing in the same field based on design incentives and market forces. Further, it would have been obvious to try combining Rossing with the teachings of Chan, for example by using an omnidirectional, unidirectional, or bidirectional microphone that is based on the sensing an incident sound-based motion of a diaphragm or a ribbon, or a condenser, an electret, a dynamic, a ribbon, a carbon, or a piezoelectric

microphone in the appliance module, without requiring much effort and with a reasonable expectation of success.

353. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by successful implementations in the field. There was a finite number of types of microphones, such as a condenser, an electret, a dynamic, a ribbon, a carbon, or a piezoelectric microphone, that were commonly known in the industry and easy to manufacture and integrate into Chan. Prior art such as Rossing has successfully demonstrated that these microphone and speaker configurations (*e.g.*, dynamic, condenser, piezoelectric, ribbon, etc.) have long been effectively implemented in consumer and industrial devices to convert acoustic signals to electrical signals and vice versa. These components were standardized, commercially available, and routinely integrated into electronic systems for reliable audio input and output. Thus, there would have been a reasonable expectation of success for combining Chan and Rossing to achieve predictable and effective microphone and speaker operation within Chan's appliance module.

3. Claim 33: "The appliance according to claim 1, wherein the first sensor is a piezoelectric sensor that includes single crystal material or a piezoelectric ceramics and uses a transverse, longitudinal, or shear effect mode of the piezoelectric effect."

354. As discussed, Chan’s appliance modules includes a number of *first sensors* responsive to physical phenomena. (*Supra*, IX.A.1.f.) For example, Chan teaches that the module “may include one or more sensors,” such as a *temperature and humidity sensor 409* that detects environmental conditions and provides corresponding data to the control circuitry. (EX1004, [0070]; FIG. 4.) Chan also discloses that the module includes “one or more *microphones*.” (EX1004, Claim 10.) A POSITA would have understood (and found it obvious) that a *microphone* is a *first sensor* because it detects the physical phenomenon of sound pressure and, like *temperature and humidity sensor 409*, would be coupled to *wireless transceiver* of the appliance module to transmit its output signal to the wireless network.

355. Chan-Rossing discloses that such microphone is a piezoelectric microphone, which includes single crystal material or piezoelectric ceramics. “Another type of self-generating microphone is the *crystal microphone*, based on the *piezoelectric effect* discovered by the Curies in 1880. Here, the diaphragm constricts a thin *crystal* made of Rochelle salt, *ceramic*, or similar material, directly producing a voltage.” (EX1010, 758.) Accordingly, Rossing confirms that piezoelectric microphones employ crystalline or ceramic piezoelectric materials to generate voltage in response to applied sound pressure.

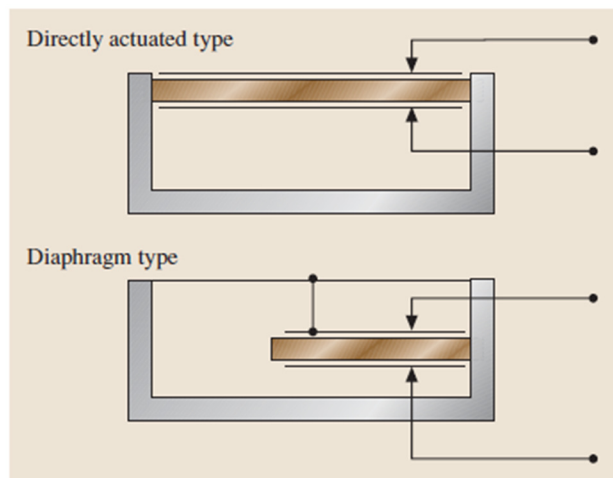


Fig. 18.12 Piezoelectric microphones (After [18.29])

356. It would have been obvious to a POSITA to use a piezoelectric microphone when implementing Chan's microphones since there were a finite number of microphone options and piezoelectric microphones were well-known. (EX1010, 758.) This is consistent with the '590 patent, which explains that a "sensor may be an electroacoustic sensor for measuring, sensing or detecting sound, such as a *microphone*. . . The microphone may be . . . a *piezoelectric microphone*." (EX1001, 17:47-54.) Considering this disclosure, a POSITA would have understood (and found it obvious) that Chan's *microphone* is a sensor, and a piezoelectric microphone is a piezoelectric sensor that converts sound pressure into an electrical signal through the piezoelectric effect.

357. A POSITA would also have understood that a *piezoelectric microphone* operates using one of the known *transverse, longitudinal, or shear modes* of the piezoelectric effect. The '590 patent itself explains that "a sensor

may be a piezoelectric sensor, where the piezoelectric effect is used to measure pressure, acceleration, strain or force. Depending on how the piezoelectric material is cut, there are three main modes of operation: transverse, longitudinal and shear.” (EX1001, 71:59-67.) A POSITA would have recognized that a piezoelectric microphone converts acoustic pressure into an electrical signal through deformation of its piezoelectric element in one of these standard modes of operation.

358. Thus, a POSITA would have understood (and found it obvious) that Chan’s *first sensor* may be implemented as a *piezoelectric microphone* comprising *single-crystal or ceramic piezoelectric material* that operates in a *transverse, longitudinal, or shear mode*.

4. Claim 48: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, an electroacoustic sensor that responds to an audible or inaudible sound.”

359. Chan discloses the first sensor consists of, or comprises, an electroacoustic sensor that responds to an audible or inaudible sound. As discussed, Chan’s appliance modules includes a number of *first sensors* responsive to physical phenomena. (*Supra*, IX.A.1.f.) For example, Chan teaches that the module “may include one or more sensors,” such as a *temperature and humidity sensor 409* that detects environmental conditions and provides corresponding data to the control circuitry. (EX1004, [0070]; FIG. 4.) Chan also discloses that the

module may include “one or more *microphones*.” (EX1004, Claim 10.) A POSITA would have understood (and found it obvious) that a *microphone* is a *first sensor* because it detects the physical phenomenon of sound pressure and, like *temperature and humidity sensor 409*, would be coupled to *wireless transceiver* of the appliance module to transmit its output signal to the wireless network.

360. Such microphone is an electroacoustic sensor that responds to an audible or inaudible sound. “[A] microphone is, of course, an analog transducer, generally used to convert acoustic signals [*i.e.*, audible or inaudible sound] to proportional electrical signals,” and that “common to virtually all microphones ever made is a diaphragm ... the sound waves impinging on a diaphragm cause movement of the diaphragm, and it is this movement that is sensed and converted to an electrical audio signal.” (EX1010, 757.)

361. This is consistent with the ’590 patent, which explains that “a sensor may be an electroacoustic sensor for measuring, sensing or detecting sound, such as a *microphone*,” and that such a sensor “*responds to audible or inaudible sound*.” (EX1001, 17:47-54.) Accordingly, a POSITA would have understood (and found it obvious) that Chan’s disclosed microphone is a *first sensor* that comprises an electroacoustic sensor responsive to audible or inaudible sound.

5. Claim 49: “The appliance according to claim 48, wherein the electroacoustic sensor is an omnidirectional, unidirectional, or bidirectional microphone that is based on the sensing an incident sound-based

motion of a diaphragm or a ribbon, and the microphone consists of, or comprises, a condenser, an electret, a dynamic, a ribbon, a carbon, or a piezoelectric microphone.”

362. Chan-Rossing discloses the electroacoustic sensor is an omnidirectional, unidirectional, or bidirectional microphone that is based on the sensing an incident sound-based motion of a diaphragm or a ribbon, and the microphone consists of, or comprises, a condenser, an electret, a dynamic, a ribbon, a carbon, or a piezoelectric microphone

363. As discussed, Chan’s appliance modules includes a number of *first sensors* responsive to physical phenomena. (*Supra*, IX.A.1.f.) For example, Chan teaches that the module “may include one or more sensors,” such as a *temperature and humidity sensor 409* that detects environmental conditions and provides corresponding data to the control circuitry. (EX1004, [0070]; FIG. 4.) Chan also discloses that the module includes “one or more *microphones*.” (EX1004, Claim 10.) A POSITA would have understood (and found it obvious) that a *microphone* is a *first sensor* because it detects the physical phenomenon of sound pressure and, like *temperature and humidity sensor 409*, would be coupled to *wireless transceiver* of the appliance module to transmit its output signal to the wireless network.

364. First, Chan-Rossing discloses the microphone is an omnidirectional, unidirectional, or bidirectional microphone. Rossing explains that “a microphone

is an audio device *inextricably tied to spatial considerations*” and that “most microphones exhibit *some directional bias* ... it is probably not possible to specify a single universally preferred pickup pattern.” (EX1010, 757.) A POSITA would have understood (and found it obvious) this to mean that microphones naturally vary in directional response and is omnidirectional, unidirectional, or bidirectional. (EX1010, 759; *see also* EX1020, 118-119.)

365. Rossing discloses that omnidirectional microphones are conventional. Rossing discloses that “for measurement of the lateral energy fraction (LEF), the early part (up to 80ms) of this lateral sound energy is compared with the energy of the direct sound plus all early reflections picked up by an *ordinary omnidirectional microphone* where h_l is the impulse response pressure recorded with a figure-of-eight microphone, whereas h is captured through the (*usual*) *omnidirectional microphone*.” (EX1010, 309; *see also*, EX1020, 118-119.) A POSITA would have understood (and found it obvious) that such omnidirectional microphones are conventional, widely known and widely available.

366. Second, Chan-Rossing discloses the microphone that is based on the sensing an incident sound-based motion of a *diaphragm*. Rossing states that “[c]ommon to virtually all microphones ever made is a *diaphragm*. Most microphones do not directly sense the instantaneous pressure deviations of an airborne acoustic wave. Instead, the *sound waves impinging* on a *diaphragm*

cause movement of the diaphragm, and it is this movement that is sensed and converted to an electrical audio signal.” (EX1010, 757.) A POSITA would therefore have recognized that microphones—including those disclosed by Chan—operate by sensing sound-induced diaphragm motion.

367. Chan-Rossing also discloses the microphone consists of, or comprises, a condenser, an electret, a dynamic, a ribbon, a carbon, or a piezoelectric microphone. “Two types of microphones avoid any mechanical attachment to the diaphragm: the *ribbon microphone* and the *condenser microphone*. A popular variant of the dynamic microphone, the ribbon microphone, uses a thin metal ribbon diaphragm suspended in a magnetic field. Movement of the diaphragm induces a current in the diaphragm, which can then be amplified. In effect, the diaphragm acts as a single-turn moving coil.” (EX1010, 758.) “The condenser microphone is based on the notion of electrical capacitance. A metal, or other conducting, diaphragm is placed close to a second, fixed conducting plate, forming a capacitor, and a polarizing voltage is applied between the plates. Movement of the diaphragm causes alterations in the capacitance, in turn causing corresponding alteration of the charge on the plates, which is converted to a dynamic voltage by a resistor, and amplified as necessary.” *Id.*

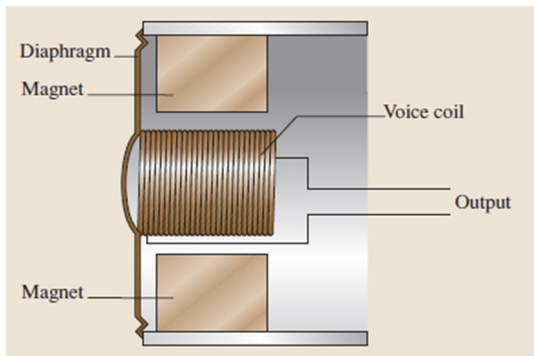


Fig. 18.10 A dynamic microphone uses a coil of wire attached to a diaphragm, suspended in a magnetic field (After [18.24])

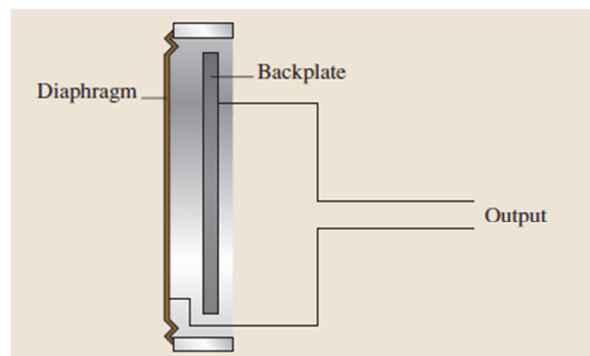


Fig. 18.9 A condenser microphone consists of a very thin diaphragm suspended parallel to a backplate (After [18.24])

368. Chan-Rossing discloses *piezoelectric microphones* and *carbon microphones*. “Many early telephone transmitters used carbon in one form or another, typically *carbon granules* coupled to the diaphragm such that vibration of the diaphragm would dynamically squeeze the granules, causing a variation in resistance that could be electrically sensed by an applied voltage. This arrangement could be scaled up in size and voltage enough to produce a sizeable signal, of particular importance prior to the advent of electrical amplification.” (EX1010, 758.) “Another type of self-generating microphone is the *crystal microphone*, based on the *piezoelectric* effect discovered by the Curies in 1880. Here, the diaphragm constricts a thin crystal made of Rochelle salt, ceramic, or similar material, directly producing a voltage. The low compliance of the piezoelectric element typically limits the performance of such a microphone, especially the extent of its frequency response.” *Id.*

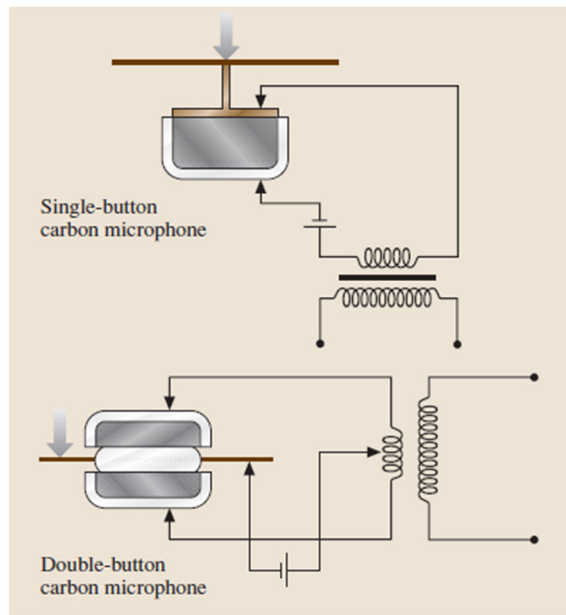


Fig. 18.11 A carbon microphone (After [18.25])

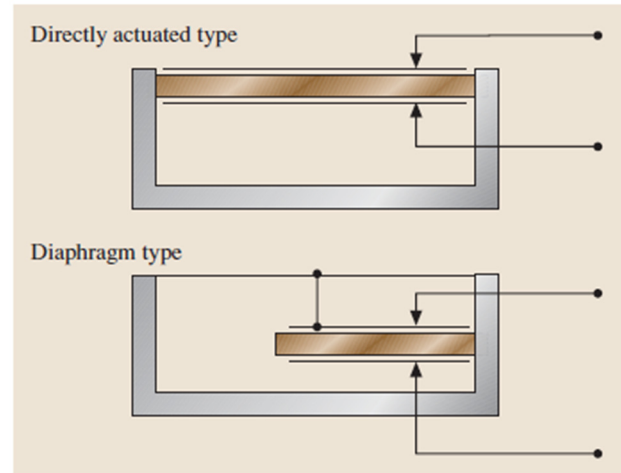


Fig. 18.12 Piezoelectric microphones (After [18.29])

369. Further, Rossing discloses an *electret* microphone. “A popular modern variant is the *electret condenser microphone*, perfected in 1962 by Sessler and West of Bell Laboratories. An electret is an object possessing a permanent electrostatic charge, making it rather like the electrical analog of the permanent magnet. Use of an electret to polarize the capacitor in a condenser microphone eliminates the need to supply a polarizing voltage for the capacitor. Since electret condenser microphones are used almost universally in cell phones, as well as other applications, they are probably the most popular type in current use. The diaphragm of electret condenser microphones is usually made of a thin sheet of flexible plastic which has had a metal coating deposited on it, a notably lightweight arrangement that permits good sensitivity and frequency response. Such microphones also usually exhibit good sample-to-sample consistency, making

them *practical for multi-microphone arrays.*” (EX1010, 759; *see also*, EX1020, 119-120.)

370. Accordingly, in view of Chan and Rossing, a POSITA would have understood (and found it obvious) that Chan’s microphone would be implemented as an omnidirectional electroacoustic sensor that senses sound through movement of a diaphragm or ribbon and comprises a condenser, electret, dynamic, ribbon, carbon, or piezoelectric microphone.

6. Claim 55: “The appliance according to claim 53, wherein the actuator consists of, or comprises, a sounder for converting an electrical energy to omnidirectional, unidirectional, or bidirectional pattern emitted, audible or inaudible, sound waves.”

371. Chan-Rossing discloses the actuator consists of, or comprises, a sounder for converting an electrical energy to omnidirectional, unidirectional, or bidirectional pattern emitted, audible or inaudible, sound waves.

372. First, Chan-Rossing discloses the actuator consists of, or comprises, a sounder. As discussed above, Chan discloses that its *appliance module* includes various actuators activated or controlled in response to digital data received from the wireless network. (*Supra* § IX.A.13.) For example, Chan explains that the *appliance module* “may be adapted to measure, store and/or control energy usage of connected appliances or devices,” and that command or control information is be transmitted “from gateway 300 to *appliance module* 111 ... to turn the

connected appliance on or off.” (EX1004, [0057], [0076]; *see also* EX1004, [0009], [0047], [0109], [0113], FIG. 11, Claim 1.) Chan also discloses that the **appliance module** comprises “one or more audio devices.” (EX1004, Claim 11.)

A POSITA would have understood (and found it obvious) that an audio device such as a **speaker** is an **actuator** by converting an incoming electrical signal into sound energy, thereby performing an output function responsive to wireless control data. (EX1001, 105:48-106:18.) A POSITA would have also understood that, like other actuators in Chan’s module (*e.g.*, relay 423 or LED indicator), the speaker would be ***coupled to the internal control circuitry and wireless transceiver*** so that it is activated or modulated in response to digital data received from the wireless network (for example, to provide an audio alert that the appliance is switching on or off). A POSITA would have been motivated to include a speaker in Chan’s appliance module to output feedback to a user regarding the status of the appliance (*e.g.*, alerting the user that it would switch the appliance off).

373. Second, Chan-Rossing’s **audio device** (*e.g.*, speaker) is a sounder for converting electrical energy to sound waves. “Most loudspeakers use the moving-coil principle (Figure 10.8). The coil is wound on a former at the apex of a stiff diaphragm which is held in flexible supports so that the coil is the intense field of a permanent magnet. A signal current through the coil will then ***vibrate the diaphragm, producing sound waves*** at the same frequency and with the same

waveshape as the signal.” (EX1020, 122, 123.) Accordingly, Chan’s audio device is a ***sounder*** that transforms electrical energy into sound waves.

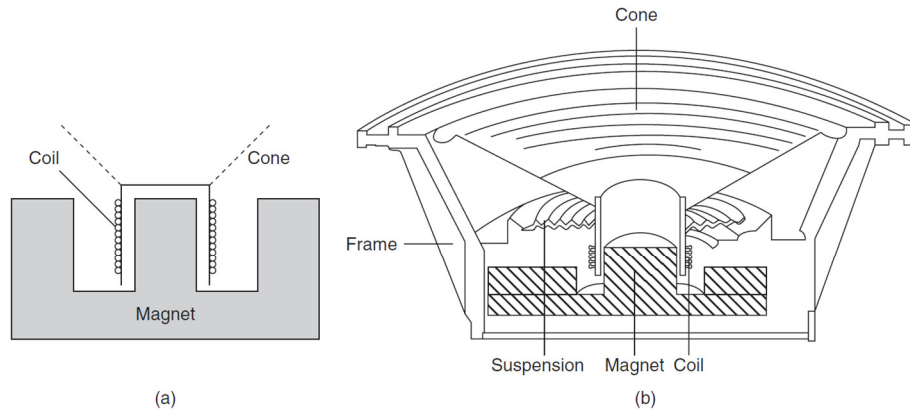


Figure 10.8 Moving-coil loudspeaker: (a) cross-section of coil and magnet, and (b) cutaway view of complete unit

374. Third, Chan-Rossing’s speaker operates by emitting audible sound waves that are of an omnidirectional, unidirectional, or bidirectional pattern. For example, “[s]ound ***radiates from a loudspeaker in all directions***, depending on angle and frequency ... It is rare for a speaker to have truly constant directionality across its entire pass-band, in part from that fact that most ***are at least somewhat directional at mid and high frequencies***, and, because of the long wavelengths involved, almost unavoidably ***omni-directional at low frequencies***.” (1010, 765.)

375. A POSITA would therefore have understood that Chan’s audio device (speaker) functions as an actuator comprising a ***sounder*** that converts electrical energy into emitted audible (or inaudible) sound waves in an omnidirectional, unidirectional, or bidirectional pattern.

7. Claim 56: “The appliance according to claim 53, wherein the actuator consists of, or comprises, an electromagnetic coil or an electromagnet operative for generating a magnetic or electric field.”

376. Chan-Rossing disclose the actuator consists of, or comprises, an electromagnetic coil or an electromagnet operative for generating a magnetic or electric field. As discussed above, Chan’s *appliance module* includes one or more *audio devices*, such as a speaker, which are activated in response to digital data received from the wireless network. (EX1004, Claim 11; [0057], [0076]; *supra* § IX.A.13, § IX.F.6.) A POSITA would have been motivated to include such a *speaker actuator* in Chan’s appliance module to provide audible feedback to the user regarding appliance status (for example, signaling that the appliance will turn on or off). Like other actuators in Chan’s system (*e.g.*, relay switch 423 or LED indicators), a POSITA would have understood (and found it obvious) that the speaker would be coupled to the *appliance module’s* control circuitry and wireless transceiver so that it could be activated in response to wireless command data.

377. Chan-Rossing discloses a speaker consists of, or comprises, an electromagnetic coil or an electromagnet operative for generating a magnetic or electric field. “Most loudspeakers use the moving-coil principle (Figure 10.8 [below]). The coil is wound on a former at the apex of a stiff diaphragm which is held in flexible supports so that the *coil is the intense field of a permanent magnet*. A signal current through the coil will then vibrate the diaphragm,

producing sound waves at the same frequency and with the same waveshape as the signal.” (EX1020, 122, 123.) “An example of a transducer is a loud-speaker, which converts an electrical signal into a variable *magnetic field* and, subsequently, into acoustic waves.” (EX1012, 3.)

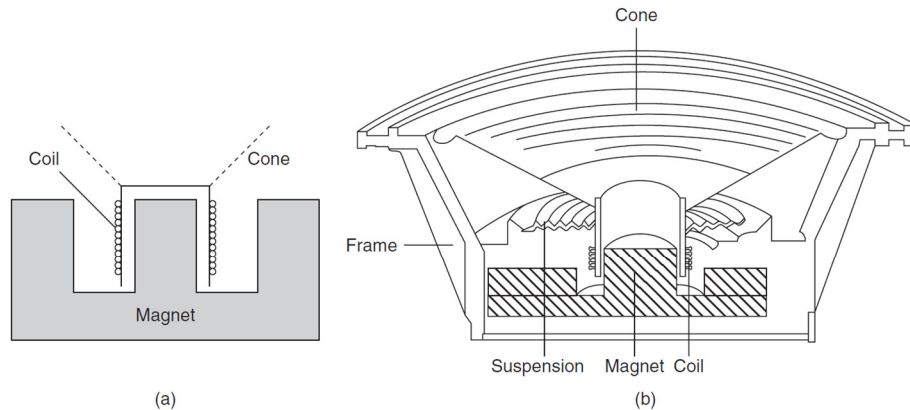


Figure 10.8 Moving-coil loudspeaker: (a) cross-section of coil and magnet, and (b) cutaway view of complete unit

378. Accordingly, a POSITA would have recognized that Chan’s speaker actuator includes an *electromagnetic coil or electromagnet* that generates a magnetic field in response to an applied electrical signal.

G. Ground 7: Chan in view of Benesty Render Obvious Claims 35-36, 39, 40, 42, 43, 47

1. Summary of Benesty

379. Benesty was published by at least December 11, 2007, before the earliest provisional application filing date of the ’590 patent, and thus qualifies as prior art under §102(b). (EX1033.) The Examiner never found, and Applicant never cited, Benesty during prosecution. Benesty is a textbook titled “Springer

Handbook of Speech Processing.” (EX1009, Title.) Benesty provides an overview of well-known speech processing techniques, including speech recognition, speaker recognition, speech enhancement via noise reduction, and microphone arrays.

380. Benesty discloses that “it is shown that microphone arrays have the ability to offer directional gains that can significantly improve the quality of signal pickup in reverberant and noisy environments.” (EX1009, 1021.)

381. Benesty discloses that a microphone array includes multiple microphones (*e.g.*, sensors) arranged in an array. The schematic diagram FIG. 50.1 of Benesty illustrated a uniformly spaced linear microphone array of *microphones* spaced by a distance d .

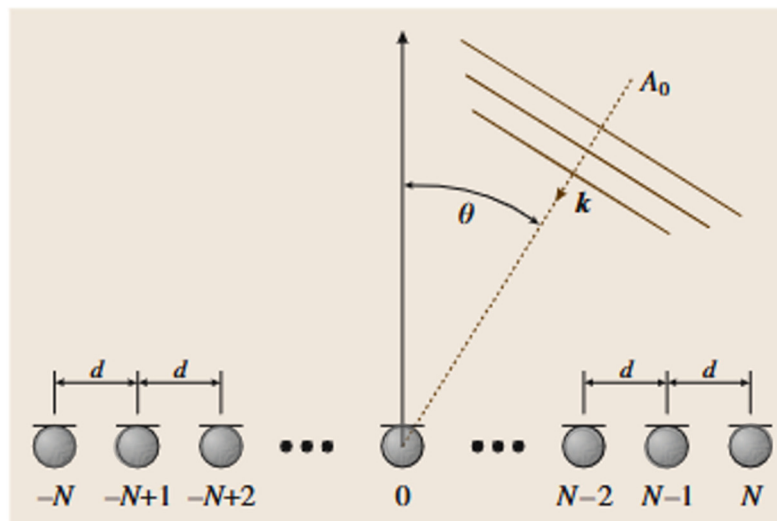


Fig. 50.1 Schematic of uniformly spaced linear array containing $2N + 1$ microphones spaced by d

382. Benesty discloses that “for speech source localization, microphone array beam scanning and time delay estimation (TDE)-based localization methods are the two most widely used approaches. A beamformer is a spatial filter that operates on the microphone outputs in order to enhance the signal coming from one direction while suppressing noise and interference from other directions. Therefore, steering a microphone array beamformer and scanning across a room for the highest-energy output lead to an *estimate of the direction* of an active speech source. Using two arrays and by intersecting the two corresponding direction estimates, the source location is determined.” (EX1009, 1044.)

383. Benesty is a textbook published by Springer and was well-known among POSITAs. A POSITA would have looked to Benesty for techniques of applying multiple sensors (*e.g.*, microphones) arranged in a directional array in a device to, for example, improve the audio signal capturing and processing.

384. Benesty is analogous to the field of the '590 patent. Both relate to microphones and audio capture systems for processing human voice data. (EX1001, 63:14-50, 134:43-52; EX1011, 1021.)

2. Motivation to combine Chan and Benesty

385. It would have been obvious to a POSITA to apply Benesty's techniques of including a microphone array to Chan's appliance module. Both Chan and Benesty are related to capturing audio data through a microphone. Chan

discloses its “appliance module compris[es] one or more microphones.” (EX1004, Claim 10.) Benesty discloses hands-free audio communication and speech processing techniques. Benesty states that “hands-free audio communication is now a major feature in mobile communication systems as well as audio and video conferencing systems. One problem that becomes evident to users of these systems is the decrease in communication quality due to the pickup of room reverberation and background noise.” (EX1011, 1021.) Thus, Chan and Benesty are analogous art to the ’590 patent, from the same field of endeavor, and all relate to the same technical problem of providing hands-free audio communication between users and devices. A POSITA would have been motivated to apply Benesty’s microphone arrays when implementing Chan to allow audio capture with higher clarity and spatial accuracy.

386. The Chan-Benesty combination results in a system where the multiple microphones in Chan are arranged in a directional array as taught by Benesty to improve the quality of captured audio. For example, Benesty’s microphone array(s) may be included in Chan’s appliance module to capture human voice data. Because Chan itself explicitly discloses microphones in its appliance module and Benesty relates to improving audio capturing through arranging the microphones in a directional array, a POSITA would be motivated to use the known techniques of Benesty to improve Chan’s microphones’ ability to capture audio, especially in a

room where the microphones are not placed near the mouth of the user. Even in use cases where background noise is desired, a microphone array can capture richer audio information, enabling more efficient and accurate processing, for example, separating or balancing speech and background noise when desired.

387. Combining the teachings of Chan and Benesty as such would yield predictable results of improving audio capturing and processing. Further, it would have been obvious to try combining the technical features of Benesty with the teachings of Chan, as there was a finite number of identified, predictable resolutions, without requiring much effort and with a reasonable expectation of success. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by successful implementations in the field. There was a finite number of potential solutions to improve audio signal pickup, such as additional software processing or incorporating additional hardware components. The known benefits of Benesty would prompt the application of Benesty in the same field based on design incentives and other market forces to produce a system architecture that responds to captured human voice data accurately, having improved audio communication signal pickup. Prior art such as Benesty has successfully demonstrated that arranging multiple microphones into directional arrays enhances voice capture quality and noise suppression in hands-free and voice-controlled systems. These configurations

were well established and commercially adopted in teleconferencing and mobile communication devices by the time of the invention. Thus, there would have been a reasonable expectation of success for combining Chan and Benesty to achieve predictable improvements in directional audio capture and signal clarity within Chan's appliance module.

3. Claim 34: “The appliance according to claim 1, further comprising multiple sensors arranged as a directional sensor array operative to estimate the number, magnitude, frequency, Direction-Of-Arrival (DOA), distance, or speed of the physical phenomenon impinging the sensor array.”

388. Chan-Benesty discloses multiple sensors arranged as a directional sensor array operative to estimate the number, magnitude, frequency, Direction-Of-Arrival (DOA), distance, or speed of the physical phenomenon impinging the sensor array.

389. First, Chan-Benesty discloses multiple sensors. Chan's “*appliance module*” compris[es] one *or more microphones*.” (EX1004, Claim 10.) A POSITA would have understood that Chan's appliance module includes multiple microphones. Consistent with the '590 patent, a POSITA would have understood (and found it obvious) the microphones to be sound sensors. (EX1001, 17:47-54 (a “sensor may be an electroacoustic sensor for measuring, sensing or detecting sound, such as a microphone. Typically microphones are based on converting audible or inaudible (or both) incident sound to an electrical signal by measuring

the vibration of a diaphragm or a ribbon. The microphone may be . . . a piezoelectric microphone.”) Rossing explains that “[c]ommon to virtually all microphones ever made is a diaphragm. Most microphones do not directly sense the instantaneous pressure deviations of an airborne acoustic wave. Instead, the sound waves impinging on a diaphragm cause movement of the diaphragm, and it is this movement that is sensed and converted to an electrical audio signal.”

(EX1010, 757.) Accordingly, a POSITA would have understood (and found it obvious) that, when utilizing Benesty’s *directional sensor array*, Chan’s *appliance module* includes multiple microphones functioning as sensors responsive to a physical phenomenon (sound) and coupled to the appliance module’s control circuitry and wireless transceiver to transmit corresponding electrical signals.

390. Second, Chan-Benesty discloses multiple sensors arranged as a directional sensor array operative to estimate the Direction-Of-Arrival (DOA), distance of the physical phenomenon impinging the sensor array. Benesty describes the use of *microphone arrays*—multiple microphones arranged in a spatial configuration—to perform directional sensing. “It is shown that *microphone arrays* have the ability to offer *directional* gains that can *significantly improve the quality of signal pickup in reverberant and noisy environments.*”

(EX1011, 1021.) “One solution is to use beamforming microphone arrays, which

can offer significant directional gain so as to result in similar audio performance to that of closely placed microphones.” *Id.*

391. A microphone array includes multiple microphones arranged in an array, as shown below. The schematic diagram FIG. 50.1 of Benesty illustrates a uniformly spaced linear microphone array by *microphones* spaced by a distance d . A POSITA would have recognized that this configuration corresponds to a directional sensor array comprising multiple microphones.

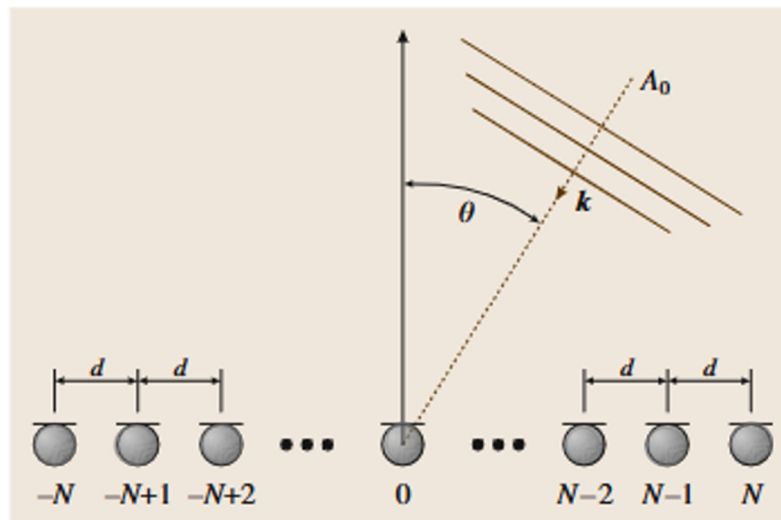


Fig. 50.1 Schematic of uniformly spaced linear array containing $2N + 1$ microphones spaced by d

392. Benesty further discloses that such arrays are used to determine the direction of arrival (DOA), location, and distance of sound sources. Specifically, “for speech source localization, microphone array beam scanning and time delay estimation (TDE)-based localization methods are the two most widely used approaches. A beamformer is a spatial filter that operates on the microphone

outputs in order to enhance the signal coming from one direction while suppressing noise and interference from other directions. Therefore, steering a microphone array beamformer and scanning across a room for the highest-energy output lead to an *estimate of the direction* of an active speech source. Using two arrays and by intersecting the two corresponding direction estimates, the source location is determined.” (EX1011, 1044.)

393. Benesty also discloses that “alternatively, a TDE-based source localization algorithm involves a two-step procedure. In the first step, a set of relative time differences of arrival (TDOAs) for different microphone pairs are calculated. In the second step, the acoustic source location is estimated from the TDOAs and using the a priori knowledge about the locations of the microphones. TDE-based source localization algorithms have many merits: they cope well with both narrowband and broadband source signals; their localization resolution can be flexibly adjusted by varying the sampling rate and microphone array size; the effect of room reverberation is only of concern in the first step TDE and several recently developed robust TDE algorithms are promising for future practical use; and in general they are computationally efficient.” (EX1011, 1044.) A POSITA would have understood (and found it obvious) that such techniques allow estimation of *direction of arrival* of the physical phenomenon impinging on the array. Accordingly, in view of Chan and Benesty, a POSITA would have found it

obvious to utilize Benesty's *multiple microphones* as a *directional sensor array* when implementing Chan's one or more microphones, such that the *appliance module* can determine properties of sound such as its direction of arrival, frequency, distance, or speed.

394. A POSITA would have understood (and found it obvious) that arranging multiple microphones in Chan's module as taught by Benesty would create a *directional sensor array* operative to estimate parameters such as the *direction of arrival* of a sound source.

H. Ground 8: Chan in view of Fraden Render Obvious Claims 35-47

1. Summary of Fraden

395. Fraden was published by at least May 10, 2011, before the earliest provisional application filing date of the '590 patent, and thus qualifies as prior art under §102(b). (EX1034.) The Examiner never found, and Applicant never cited, Fraden during prosecution.

396. Fraden is a textbook titled "Handbook of Modern Sensors: Physics, Designs, and Applications." (EX1012, Title.) Fraden provides an overview of a variety of sensors such as optical sensors, occupancy and motion sensors, pressure sensors, flow sensors, acoustic sensors, humidity and moisture sensors, light detectors, radiation detectors, temperature sensors, and chemical sensors. (EX1012, Chapters 6, 10, 11, 13, 14-17.) Fraden was published by Springer.

Fraden is analogous to the field of the '590 patent. Both relate to sensor technologies for monitoring environmental and operational conditions of appliances. (EX1001, 16:44-22:2, 62:66-81:60; EX1012, Chapters 6, 10-11, 13-17.)

2. Motivation to combine Chan and Fraden

397. It would have been obvious for a POSITA to apply Fraden's comprehensive teachings on sensors to Chan's energy monitoring and appliance control system. Both Chan and Fraden are analogous art to the '590 patent and all directed to the field of sensor technologies used for monitoring environmental and operational conditions of an appliance. Chan expressly discloses that each appliance module includes one or more sensors, such as temperature, humidity, motion, vibration, infrared, pressure, smoke, or biological sensors for monitoring appliance status and environmental conditions. (EX1004, [0070], [0109], Claims 3-16.) Fraden is a textbook on sensors operations providing detailed discussions of the design, operation, and implementation of these same types of sensors—such as temperature sensors (including thermistors, thermocouples, and RTDs), photoelectric and radiation sensors, humidity sensors, electrochemical and gas sensors, and image or optical sensors—along with their respective operation principles and practical tradeoffs. (EX1012, Chapters 6, 10, 11, 13, 14-17.) Both references are therefore from the same field of endeavor and address the same

general technical problem of accurately detecting and monitoring physical, environmental, and chemical parameters of appliances.

398. A POSITA would have been motivated to look to Fraden for well-known sensor types, operating principles, and implementation techniques that could be applied to Chan's appliance module to expand the scope of its monitoring and detection capabilities and improve the sensors' operation efficiency. Chan's disclosure that the appliance module integrates *“temperature/fog/brightness/infrared sensor 1107, a switch/relay/alarm sensor 1109,”* or *“thermal sensor, humidity sensor, security sensor, motion sensor, light sensor, pressure sensors, microphones, vibration sensors, gyro or accelerometer, smoke sensors, and biological sensors”* invites the use of standard sensors such as those described in Fraden. ([0070], [0109], Claims 3-16.)

399. A POSITA would have understood (and found it obvious) that incorporating these well-known sensor types into Chan's appliance module would be a straightforward substitution of one known sensor implementation for another known equivalent, resulting in predictable improvements in precision, reliability, and versatility of sensor measurements. For example, using Fraden's thermocouple or RTD-based temperature sensors in Chan's temperature/humidity sensing module would enhance temperature measurement accuracy and long-term

stability, while adding Fraden's optical or electrochemical sensors would enable Chan's appliance module to detect radiation, or airborne chemicals as claimed.

400. Further, combining Chan with Fraden would predictably improve Chan's system by providing a broader range of sensor modalities and better-defined implementation methods for the sensors already disclosed in Chan. Fraden compiles the conventional principles of sensor design, including their response characteristics and calibration requirements, making it an obvious reference for a POSITA seeking to implement or optimize Chan's system that expressly contemplates the integration of various types of sensors. Further, it would have been obvious to try applying the known sensor technologies taught by Fraden to Chan's appliance module, as there were a finite number of established sensor types for measuring physical, optical, chemical, and environmental phenomena. The combination would have been straightforward to implement with a reasonable expectation of success, yielding predictable results of enhancing the sensing diversity, measurement accuracy, and functionality of Chan's energy monitoring and control system.

401. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by successful implementations in the field. Prior art such as Fraden has successfully demonstrated that standardized sensor technologies (*e.g.*, thermistors, thermocouples, photoelectric detectors,

humidity sensors, accelerometers, and gas sensors) can be reliably integrated across monitoring systems to measure temperature, pressure, motion, light, and chemical composition. These sensor architectures were commercially available and routinely applied in comparable control and monitoring devices. Thus, there would have been a reasonable expectation of success for combining Chan and Fraden to achieve predictable and reliable multi-sensor functionality within Chan's appliance module.

3. Claim 35: “The appliance according to claim 1, wherein the first sensor is a thermoelectric sensor that responds to a temperature or to a temperature gradient of an object using a conduction, convection, or radiation, and wherein the thermoelectric sensor consists of, or comprises, a Positive Temperature Coefficient (PTC) thermistor, a Negative Temperature Coefficient (NTC) thermistor, a thermocouple, a quartz crystal, or a Resistance Temperature Detector (RTD).”

402. Chan-Fraden discloses the *first sensor* is a thermoelectric sensor that responds to a temperature or to a temperature gradient of an object using a conduction, convection, or radiation, and wherein the thermoelectric sensor consists of, or comprises, a Positive Temperature Coefficient (PTC) thermistor, a Negative Temperature Coefficient (NTC) thermistor, a thermocouple, a quartz crystal, or a Resistance Temperature Detector (RTD). As discussed above, Chan discloses its *appliance module 400* includes “a *temperature and humidity sensor 409*” which is a *first sensor* having an output that responds to a physical phenomenon. (EX1004, [0070], [0109], FIG. 4.) Chan describes other *first*

sensors that are integrated into the appliance module, including a “**a thermal sensor**,” or “one or more combinations of sensor devices.” (EX1004, [0070], [0109], Claim 3.)

403. Chan-Fraden discloses temperature sensor is a thermoelectric sensor that responds to a temperature or to a temperature gradient of an object using conduction, convection, or radiation. “Taking a temperature essentially requires the transmission of a small portion of the object’s thermal energy to the sensor whose function is to convert that energy into an electrical signal. When a contact sensor (probe) is placed inside or on the object, **heat conduction** takes place through the boundary between the object and the probe. The sensing element in the probe warms up or cools down, *i.e.*, it exchanges heat with the object. The same happens when heat is transferred by means of radiation - thermal energy in the form of infrared light is exchanged between the sensor and the object. Any sensor, no matter how small, will disturb the measurement site and thus cause some error in temperature measurement. This applies to any method of sensing: **conductive, convective, and radiative.**” (EX1012, 519.)

404. Chan-Fraden discloses the thermoelectric sensor consists of, or comprises, a Positive Temperature Coefficient (PTC) thermistor, a Negative Temperature Coefficient (NTC) thermistor, a thermocouple, or a Resistance Temperature Detector (RTD). Fraden discloses that **thermistors, resistance**

temperature detectors (RTDs), and *thermocouple* are common temperature sensors. (EX1012, 526; EX1020, 34.) For example, Fraden discloses that “[a]ll temperature sensors can be divided into two classes: the absolute sensors and the relative sensors. An absolute temperature sensor *measures temperature* that is referenced to the absolute zero or any other point on the absolute temperature scale, for example 0°C (273.15K), 25°C or a selected calibration temperature. Examples of the absolute sensors are *thermistors* and *resistance temperature detectors (RTDs)*. A relative sensor *measures a temperature difference* between two objects where one object is called the reference. An example of a relative sensor is a *thermocouple*.” (EX1012, 526; *see also*, EX1020, 34.) A POSITA would have understood (and found it obvious) that Chan’s “thermal sensor” or “temperature sensor 409” is a Positive Temperature Coefficient (PTC) thermistor, a Negative Temperature Coefficient (NTC) thermistor, a thermocouple, or a Resistance Temperature Detector (RTD).

4. Claim 36: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, a nanosensor, a crystal, or a semiconductor.”

405. Chan-Fraden discloses the first sensor consists of, or comprises, a nanosensor, a crystal, or a semiconductor.

406. As discussed above, Chan discloses its *appliance module 400* includes “a *temperature and humidity sensor 409*” which is a *first sensor* having

an output that responds to a physical phenomenon. (EX1004, [0070], [0109], FIG.

4.) Chan describes other *first sensors* that are integrated into the appliance module, including a “*temperature/fog/brightness/infrared sensor 1107*,” “a *thermal sensor*,” “a *humidity sensor*,” “a *security sensor*,” “a *motion sensor*,” “a *light sensor*,” “one or more *pressure sensors*,” “one or more *microphones*,” “one or more *vibration sensors*,” “*gyro* or *accelerometer*,” “one or more *smoke sensors*,” “*biological sensors*,” or “one or more combinations of sensor devices.” (EX1004, [0070], [0109], Claims 3-16.)

407. One or more of these sensors comprise a nanosensor, a crystal, or a semiconductor. For example, microphones comprise a *crystal*. “[A] capacitive microphone linearly converts a distance between the plates into electrical voltage, which can be further amplified . . . This is accomplished by a build-in electret layer, which is a *polarized dielectric crystal*.” (EX1012, 432.) “The piezoelectric effect can be used for the design of simple microphones. A *piezoelectric crystal* is a direct converter of a mechanical stress into an electric charge.” (*Id.*, 435-436.) “Another type of self-generating microphone is the *crystal microphone*, based on the piezoelectric effect discovered by the Curies in 1880. Here, the diaphragm constricts a thin *crystal* made of Rochelle salt, ceramic, or similar material, directly producing a voltage.” (EX1010, 758.)

408. Thermal sensors are commonly made from silicon, which is a semiconductor. “*Silicon* itself exhibits very useful mechanical properties, which nowadays are widely used to fabricate such devices as *pressure transducers*, *temperature sensors*, and force and tactile detectors by employing the microelectromechanical systems (MEMS) technologies .” (EX1012, 608.) “A reference temperature detector in this example is a *semiconductor sensor* LM35DZ manufactured by National Semiconductor, Inc.” (EX1012, 553.) It was well-known that semiconductors are used as temperature sensors in power measuring devices. “The characteristic curves of *semiconducting elements* change with temperature. A transistor which is heated will give a higher collector-emitter current for a fixed based-emitter voltage.” (EX1008, 134-135.)

409. Image sensors like CMOS sensors, as their names “complementary metal oxide semiconductor” suggest, also comprise a semiconductor. “The charge-coupled device (CCD) and complementary metal oxide *semiconductor* (CMOS) image sensors are two different technologies presently used for capturing images digitally” and “[l]ike CCDs, these imagers are made from *silicon*.” (EX1012, 478, 480.)

5. Claim 39: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, a bulk or surface acoustic sensor.”

410. Chan-Fraden discloses the first sensor consists of, or comprises, a surface acoustic sensor.

411. As discussed, Chan discloses other *first sensors* that are integrated into the appliance module, including “*temperature/fog/brightness/infrared sensor 1107*,” “*a thermal sensor*,” “*a humidity sensor*,” “*one or more pressure sensors*,” “*one or more vibration sensors*,” “*gyro or accelerometer*,” and “*biological sensors*.” (EX1004, [0070], [0109], Claims 3, 4, 9, 12, 13, and 15.)

412. Fraden discloses that temperature sensors may be acoustic sensors. “A miniature *temperature sensor* can be fabricated with the *surface acoustic waves* (SAW) and plate waves (PW) techniques (see Section 12.7). The idea behind such a sensor is in the temperature modulation of some mechanical parameters of a time-keeping element in the electronic oscillator [24, 25]. This leads to a change in the oscillating frequency. In effect, such an integral acoustic sensor becomes a direct converter of temperature into frequency.” (EX1012, 564-565.)

413. Fraden also discloses that humidity sensors consist of, or comprise, SAW sensors. “The idea behind the oscillating *hygrometer* is similar to that behind the optical-chilled mirror sensor. The difference is that the measurement of the dewpoint is made not by the optical reflectivity of the surface, but rather by detecting the changing mass of the chilled plate Naturally, *this method may*

be employed by using the SAW sensors, similar to that of Fig. 12.9 where the stimulus place is the area subjected to the sampled gas.” (EX1012, 458, 442.)

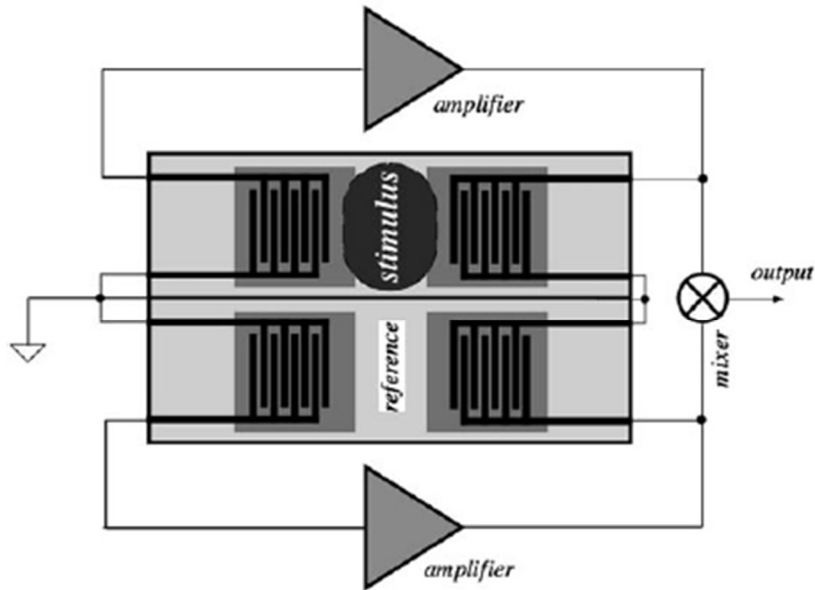


Fig. 12.9 Differential SAW sensor

414. Further, Fraden discloses use of a “surface acoustic wave (SAW) device” for “detecting mechanical vibrations in solid.” (EX1012, 440.)

“Nowadays, use of the acoustic sensors is broader than detecting sound waves in air. Particularly they become increasingly popular for *detecting mechanical vibrations* in solid for fabrication such sensors as microbalances and *SAW devices*. Applications range over measuring displacement, concentration of compounds, *stress, force, temperature*, etc. All such sensors are based on elastic motions in solid parts of the sensor and their major use is serving as parts in other, more complex sensors, for instance, in chemical detectors, *accelerometers, pressure*

sensors, etc. In chemical and *biological sensors*, the acoustic path, where mechanical waves propagate, may be coated with chemically selective compound, which interact only with the stimulus of interest.” (EX1012, 440.)

415. It would have been obvious to a POSITA to implement Chan’s *temperature and humidity sensor* with surface acoustic sensors.

6. Claim 40: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, a radiation sensor that responds to radioactivity, nuclear radiation, alpha particles, beta particles, or gamma rays, and is based on a gas ionization.”

416. Chan-Fraden discloses the first sensor consists of, or comprises, a radiation sensor that responds to radioactivity, nuclear radiation, alpha particles, beta particles, or gamma rays, and is based on a gas ionization.

417. As discussed, Chan discloses that a variety of first sensors are integrated into the appliance module. (EX1004, [0070], [0109], Claims 3-16.)

418. Fraden provides an overview on radiation sensors. “The function of any *radiation detector* depends on the manner in which the *radiation interacts with the material of the detector* itself . . . There are four general types of radiation detectors: the scintillation detectors, the gaseous detectors, the liquid detectors, and the semiconductor detectors.” (EX1012, 503-504.) Fraden discloses that radiation sensor based on gas ionization is the most widely used. Ionization detectors “rely on the ability of some gaseous and solid materials to produce ion pairs in response

to the *ionization radiation*. Then, positive and negative ions can be separated in an electrostatic field and measured. These radiation detectors [*i.e.*, ionization chambers] are the oldest and most widely used. The ionizing particle causes the *ionization and excitation of gas molecules* along its passing track. As a minimum, the particle must transfer an amount of energy equal to the ionization energy of the gas molecule to permit the ionization process to occur.” (EX1012, 504-505.)

419. In light of Fraden, a POSITA would have understood (and found it obvious) that a radiation sensor responds to radiation such as “the so-called *nuclear radiation*, which is emission of particles from the atomic nuclei” or “[t]he charged particles (*α and β particles*, and protons). (EX1012, 503.) It would thus have been obvious to incorporate such a radiation sensor into Chan and/or try it when implementing Chan’s various sensors and expand its functionalities.

7. Claim 42: “The appliance according to claim 41, wherein the photoelectric sensor is based on the photoelectric or photovoltaic effect, and consists of, or comprises, a semiconductor component that consists of, or comprises, a photodiode, a phototransistor, or a solar cell.”

420. Chan-Fraden discloses the photoelectric sensor is based on the photoelectric or photovoltaic effect, and consists of, or comprises, a semiconductor component that consists of, or comprises, a photodiode, a phototransistor, or a solar cell. As discussed, Chan discloses its appliance comprises a photoelectric

sensor. (Supra § IX.A.26.) A photoelectric sensor is based on the photoelectric or photovoltaic effects. (EX1012, 472.)

421. Further, in light of Fraden, a POSITA would have also understood that the photoelectric sensor comprises a semiconductor component that comprises a photodiode, a phototransistor, or a solar cell. Fraden discloses several types of photoelectric sensors including photodiodes, phototransistors and solar cells.

“Photodiodes are *semiconducting* optical sensors, which if broadly defined may even include *solar batteries*.” (EX1012, 465.) “As a *photodiode*, a photoresistor is a *photoelectric device*.” (EX1012, 472.) “A photodiode directly converts photons into charge carriers, specifically one electron and one hole (hole-electron pair) per a photon. The *phototransistors* can do the same, and in addition to provide current gain, resulting in a much higher sensitivity.” (EX1012, 471.)

8. Claim 43: “The appliance according to claim 41, wherein the photoelectric sensor is based on Charge-Coupled Appliance (CCD) or a Complementary Metal-Oxide Semiconductor (CMOS) element.”

422. Chan-Fraden discloses the photoelectric sensor is based on Charge-Coupled Appliance (CCD) or a Complementary Metal-Oxide Semiconductor (CMOS) element. As discussed, Chan discloses its appliance comprises a photoelectric sensor. (Supra § IX.A.26.)

423. Chan-Fraden discloses that such photoelectric sensors are based on Charge-Coupled Appliance (CCD) or a Complementary Metal-Oxide

Semiconductor (CMOS) element. “The *charge-coupled device (CCD) and complementary metal oxide semiconductor (CMOS) image sensors* are two different technologies presently used for capturing images digitally . . . Both types of imagers *convert light into electric charge and process it into electronic signals*. In a CCD sensor, every pixel’s charge is transferred through a very limited number of output nodes (often just one) to be converted to voltage, buffered, and sent off-chip as an analog signal. Then, the analog signal is digitized by an external A/D converter. All of the pixels can be devoted to light capture, and the output’s uniformity (a key factor in image quality) is high. In a CMOS sensor, each pixel has its own charge-to-voltage conversion, and the sensor often also includes amplifiers, noise correction, and digitization circuits, so that the chip outputs digital bits.” (EX1012, 478.)

424. “Like CCDs, CMOS imagers include an array of *photosensitive diodes (PD)*, one diode within each pixel.” (EX1012, 480.) Fraden discloses that the CCD sensor consists of “a CCD chip [which] is divided into pixels. Each pixel has a potential well that collects the electrons produced by the *photoelectric effect*.” (EX1012, 479.)

425. It would have been obvious to try them when implementing Chan’s light sensor or camera sensors.

9. Claim 47: “The appliance according to claim 46, wherein the electrochemical sensor consists of, or comprises, a pH meter or a gas sensor responding to a presence of radon, hydrogen, oxygen, or Carbon-Monoxide (CO), or wherein the electrochemical sensor is based on an optical detection or on an ionization and is a smoke, a flame, or a fire detector, or is responsive to a combustible, flammable, or toxic gas.”

426. Chan-Fraden discloses the electrochemical sensor is based on an optical detection or on an ionization and is a smoke, a flame, or a fire detector. As discussed, Chan describes other *first sensors* that are integrated into the appliance module, such as “one or more *smoke sensors*.” (EX1004, [0070], [0109], Claims 14, 16; *Supra* §IX.A.29.)

427. Fraden provides an overview of smoke sensors. Smoke sensors are electrochemical sensors commonly based on an optical detection or on an ionization. “Smoke and air gas impurity sensors are intended for detecting presence of small airborne particles and have wide range of applications. Even though these detectors do not monitor air flow, their operation essentially requires movement of gas through the detection chamber of the sensor. By far the most popular are the smoke detectors . . . To detect presence of small particles suspended in air, *nowadays two types of sensors are widely employed: ionization and optical detectors.*” (EX1012, 424.)

428. Regarding ionization detectors, Fraden discloses that “[t]his detector is especially useful for *detecting smoke* composed of very small particles

(submicron) like those generated by large hot fires. The key part of this type of sensor is an ionization chamber containing less than a milligram of radioactive element Americium-241 (Am241). When smoke is drawn into the ionization chamber between the plates, the smoke particles absorb alfa-radiation, thus reducing *air ionization* and subsequently current i drops. This increases voltage at input of the amplifier, manifesting presence of smoke inside the ionization chamber.” (EX1012, 424-426.)

429. Regarding optical detectors, Fraden discloses that “[a]nother type of a *smoke or dust detector* is based on *measuring scattering of light* (see Sect. 3.13.2). An optical detector includes a light emitter (incandescent bulb, infrared LED or a laser diode) and a photosensor, usually a photodiode or phototransistor (Fig. 11.23) . . . In presence of clean air inside the scattering chamber, light beams from the emitter cannot reach the photo sensor (in empty space, light cannot go around the corner) and thus the photo sensor produces a very low output current, called the dark current (see Sect. 14.2). When dust or smoke enters the scattering chamber, it appears across the path of the light beam and some light is scattered by the particles in all directions (Fig. 11.24), including a direction toward the photo sensor.” (EX1012, 426-428.)

430. It would thus have been obvious to try such sensors when implementing smoke sensors in Chan.

**I. Ground 9: Chan in view of Doherty Render Obvious Claims
60-63**

1. Summary of Doherty

431. Doherty was published in 2007, before the earliest provisional application filing date of the '590 patent and thus qualifies as prior art under §102(a) and (b). The Examiner never found, and Applicant never cited, Doherty during prosecution. Doherty is a textbook titled “Wireless Home Networking Simplified” published by Cisco. (EX1013, Title.) Doherty teaches readers to set up wireless networks at home using conventional products. (EX1013, Introduction, Chapter 6.) A POSITA would have looked to Doherty for wirelessly connecting in-home devices.

432. Doherty is analogous to the field of the '590 patent. Both relate to wireless networking and communication among devices. (EX1001, 8:25-32, 45:49-67, 47:34-51, 152:18-38; EX1013, Introduction, ch. 6.)

2. Motivation to combine Chan and Doherty

433. It would have been obvious for a POSITA to apply Doherty's teachings on addressable wireless home networking to Chan's appliance energy monitoring and control system. Both Chan and Doherty are directed to the field of wireless communication among in-home devices, including connection to a home network for data exchange and remote control. Chan discloses that its appliance module communicates wirelessly with a gateway over various wireless

technologies such as “WiFi, *ZigBee*, *Bluetooth*, *WPAN*, RFID, *UWB*, infrared (IR), or other media.” (EX1004, [0070], [0073].) Doherty provides detailed explanation of how conventional wireless home networks operate, including the idea of addressing each networked device to the wireless network. (EX1013, 99, 100, 166, 108, 210, 175.) Thus, both references are from the same field of endeavor and are reasonably pertinent to the same technical problem of enabling wireless communication and device identification within a home network.

434. A POSITA would have been motivated to combine the teachings of Chan and Doherty so that the wireless *appliance modules* in Chan’s system could be uniquely addressable within the home wireless network or over the Internet. Doherty explicitly teaches that each device participating in the home wireless network must have a distinct, locally or universally administered digital address, such as a MAC address or an assigned IP address for routing communications. Incorporating Doherty’s addressing scheme into Chan’s system would have been a straightforward and predictable combination, allowing each appliance module to be uniquely identified by the gateway and other devices on the network. This would facilitate and enable direct control and data exchange with the gateway, and/or other devices and appliances. Further, assigning distinct Mac and IP addresses to each appliance module would allow the energy monitoring system to easily monitor the different tracked appliances and simplify network management.

At the time of the invention, there was a finite number of well-established methods for uniquely identifying networked devices, such a locally or universally administered address (*e.g.*, MAC address or IP address), and a POSITA would have found it obvious to apply these to Chan's wireless appliance module. The known benefits of addressing appliances in the wireless network using distinct addresses as taught by Doherty would prompt the application of Doherty in the same field based on design incentives and other market forces.

435. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by widespread and successful implementations of standardized addressing schemes in consumer and home networking systems. Prior art such as Doherty has successfully demonstrated that the use of MAC and IP addresses enables reliable device identification, network routing, and management in wireless local area networks (WLANs) and Internet-connected home systems. Thus, there would have been a reasonable expectation of success for combining Chan and Doherty to achieve predictable and reliable addressable communication among the appliance modules within Chan's energy monitoring and control network.

3. Claim 60: "The appliance according to claim 1, further being addressable in the wireless network using distinct locally administered addresses or universally administered digital addresses stored in a volatile or non-volatile memory in the single enclosure, which uniquely identifying the appliance in the wireless network or in the Internet."

436. Chan discloses the appliance module is addressable in the wireless network using distinct locally administered addresses or universally administered digital addresses, such as a universally administered MAC address assigned to the device's wireless network interface card (NIC) at the time of the manufacture, or a locally administered address later assigned.

437. As discussed, Chan discloses its *appliance module* communicates over various wireless communication protocols. (*Supra*, §IX.A.2.g.) Doherty discloses that “[e]ach computer or device that you want to join your wireless network needs a wireless network interface card (NIC)” and “*each wireless card has a unique identifier called a MAC address.*” (EX1013, 99, 166.) This unique identifier is assigned to the NIC at its manufacture and is thus a universally administered address (locally stored in the non-volatile memory). “[A] *MAC address . . . is a 48-bit binary number generally written as 12 hexadecimal digits (six groups of two digits, the groups separated by dashes or colons).* The address is *set at the time of the NIC’s manufacture . . .* The second least significant bit of the most significant byte MAC address is known as the *universal or locally administered address (U/L) bit* . If this bit is set to 0, the address is administered universally. This means that the address was assigned by the Institute of Electrical and Electronics Engineers (IEEE) and is unique across the globe. If the bit is set to

1, it indicates that the address was selected locally by a network administrator (overriding the NIC's BIA)." (EX1027, 24.)

438. A POSITA would have understood (and found it obvious) that these addresses uniquely identify the appliance module in the wireless network or in the Internet. For example, as discussed, if the MAC address is administered universally, the address is "*unique across the globe.*"

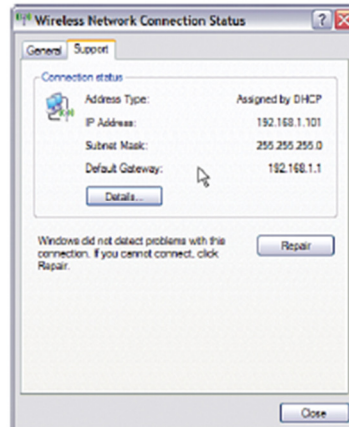
439. Further, "each device (computer, laptop, and so on) *in a home network* needs to have an *IP address*, which is how the device is known on the network . . . Most home networks use IP addresses in the range of 192.168.1.100 to 192.168.1.149, and the *router assigns each device an address* from this pool when it boots." (EX1013, 108, 210, 175.) A POSITA would have understood that IP addresses are locally administered. "Internet protocol (IP) addresses are the *unique numbers used to identify individual connections* to the Internet."

(EX1025, 127.) A POSITA would have understood (and found it obvious) that the IP address may be an assigned IP address for the device (*e.g.*, by the router), the router's IP address, a combination of the two, or a globally unique IP address.

440. As shown in the figure below, Doherty discloses that networked devices display the IP address assigned, which means the IP address is locally stored in the device. (EX1013, 211, Figure 10-44, 265.) Thus, a POSITA would

have understood (and found it obvious) that the Chan's appliance locally stores the IP address in a volatile or non-volatile memory.

Figure 10-44 Verifying IP Address Assignment with Windows XP



4. Claim 61: “The appliance according to claim 60, wherein the digital address is a Media Access Control (MAC) layer address that is MAC-48, Extended Unique Identifier (EUI) EUI-48, or EUI-64 address type.”

441. Chan-Doherty discloses the digital address is a Media Access Control (MAC) layer address that is MAC-48, Extended Unique Identifier (EUI) EUI-48, or EUI-64 address type. As discussed, Chan discloses its appliance is addressable in the wireless network using a Media Access Control (MAC) layer address.

(*Supra*, §IX.I.3.)

442. At the time of the invention, it was well-known that networked devices are associated with MAC addresses of the MAC-48, EUI-48, or EUI-64 type. For example, Doherty discloses that “[e]ach computer or device that you want to join your wireless network needs a wireless network interface card

(NIC)” and “*each wireless card has a unique identifier called a MAC address.*”

(EX1013, 99, 166.) A POSITA would have known (and found it obvious that)

“[m]ost MAC addresses use one of the IEEE standardized protocols; *MAC-48, EUI-48®, and EUI-64®.*” (EX1048, 2:50-59.)

5. Claim 62: “The appliance according to claim 60, wherein the digital address is a layer 3 address and is static or dynamic Internet Protocol (IP) address that is IPv4 or IPv6 type address.”

443. As discussed, Chan discloses its appliance is addressable in the wireless network using an Internet Protocol (IP) address. (*Supra*, §IX.I.3.)

444. Further, as discussed, Chan discloses its appliance module communicates with a wireless network. (*Supra*, §IX.A.2.c.)

445. A POSITA would have understood (and found it obvious) that this involves assigning each device with a device identifier or address such as an IP address. For example, Doherty discloses that “*each device (computer, laptop, and so on) in a home network needs to have an IP address*, which is how the device is known on the network . . . Most home networks use IP addresses in the range of 192.168.1.100 to 192.168.1.149, and the *router assigns each device an address* from this pool when it boots.” (EX1013, 108, 210, 175.)

446. At the time of the invention, it was well-known that Internet Protocol (IP) addresses are layer 3 addresses, either static or dynamic, and are IPv4 addresses. “In the case of today’s Internet, these addresses are Internet protocol

version 4 (IPv4) addresses.” (EX1025, 127.) “Internet protocol (IP) addresses are the unique numbers used to identify individual connections to the Internet.” *Id.* “Internet Protocol (IP) is a Layer 3 protocol that contains addressing and control information that allows packets to be routed.” (EX1027, 11.) “The IP system in common use today is known as IPv4, for Internet Protocol version 4. A newer system, IPv6, or Internet Protocol version 6, has been developed and exists today in small deployments.” (EX1027, 13.)

447. Further, Doherty discloses that IP addresses are either static or dynamic. “The broadband networks typically assign a *dynamic IP address* to your broadband service. Dynamic means the IP address can change[.]” (EX1013, 277.) Further, an IP address may be a “*static IP address*, which means . . . your address never changes.” *Id.*

6. Claim 63: “The appliance according to claim 60, wherein the digital address is autonomously assigned, or wherein the digital address is assigned by another appliance using Dynamic Host Configuration Protocol (DHCP).”

448. Chan-Doherty discloses the digital address is assigned by another appliance using Dynamic Host Configuration Protocol (DHCP). As discussed, Chan discloses that digital addresses such as IP address is assigned to the appliance. (*Supra*, §IX.I.3.)

449. As discussed, such IP addresses may be dynamic IP addresses. (*Supra*, §IX.I.5.) A POSITA would have understood (and found it obvious) that dynamic IP addresses are autonomously assigned and are assigned by another appliance using Dynamic Host Configuration Protocol (DHCP). For example, Doherty discloses that “[m]ost home networks use IP addresses in the range of 192.168.1.100 to 192.168.1.149, and *the router assigns* each device an address from this pool when it boots. This is called dynamic IP addressing, or *Dynamic Host Configuration Protocol (DHCP)* . . . With dynamic IP addressing, or DHCP, enabled on the wireless router, when a NIC establishes a new wireless connection, it then requests an address from the router, and the router assigns the next available one from the pool.” (EX1013, 210.) “[*D*ynamic host configuration protocol (DHCP), [] allows end-user hosts to be configured *automatically with an address* for the duration of their use. When a DHCP client starts up it searches for a DHCP server and obtains set-up information, including an IP address[.]” (EX1025, 135.)

J. Ground 10: Chan in view of Ozturk Renders Obvious Claim 59

1. Summary of Ozturk

450. Ozturk was published by at least September 2008 and is prior art under 35 U.S.C. §102(b). (EX1036.) The Examiner never found, and Applicant never cited, Ozturk during prosecution. Ozturk is an IEEE article about forced air cooling of CPUs using heat sinks and fans. (EX1014.) A POSITA would have

looked to Ozturk when implementing Chan's CPU. Ozturk is analogous to the field of the '590 patent. Both relate to electronic systems employing a central processing unit (CPU) and address thermal management through cooling mechanisms such as forced-air convection. (EX1001, 14:52-63, 26:16-31, 89:19-22, FIG. 4; EX1014, 650.)

2. Motivation to Combine Chan and Ozturk

451. Chan and Ozturk are analogous art to the '590 patent. Both relate to electronic systems employing a central processing unit (CPU) and address the common technical problem of maintaining safe operating temperatures for electronic components. Chan discloses that its appliance module comprises a "CPU 401" coupled to first sensors such as current transformers 425b and temperature and humidity sensors 409. (EX1004, [0070], FIG. 4.) Ozturk provides a detailed analysis of conventional CPU cooling techniques employing forced-air convection through a fan-and-heatsink assembly. (EX1014, 650.) Thus, both references are from the same field of endeavor (electronic systems incorporating CPUs) and address the same general problem of dissipating heat generated by processing components.

452. A POSITA would have been motivated to combine the teachings of Ozturk with Chan to include a fan and heatsink assembly for cooling Chan's CPU 401. A POSITA would have understood (and found it obvious) that integrating

such a cooling mechanism in Chan's appliance module would maintain optimal CPU operating temperatures and enhance the long-term stability and reliability of the energy monitoring and control system.

453. The inclusion of a heatsink and fan assembly for cooling a CPU would have been an obvious and predictable modification at the time of the invention. Forced-air convection cooling was a mature, standardized technology by 2012 and widely implemented in computer and embedded control systems. A POSITA would have recognized that such cooling assemblies could be readily adapted for Chan's CPU 401 using standard mounting and power configurations, without the need for inventive skill. Further, the use of forced convection by means of a fan was well-known to be an effective and efficient thermal management approach. As described by Fraden, "[h]eat transfer from a solid body to a moving agent or within the moving agent is also called convection. Convection may be natural (gravitational) or forced (produced by a mechanism)... Forced convection of air is produced by a fan or blower." (EX1012, 125.) Thus, incorporating Ozturk's forced-air cooling principles into Chan's CPU system would have predictably improved thermal regulation by removing heat dissipated from the processing unit via forced convection.

454. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by successful implementations in the

field. Prior art such as Ozturk has successfully demonstrated that CPU cooling assemblies employing a fan and heat sink provide efficient and reliable heat dissipation in numerous electronic systems, ensuring stable processor operation and extending component lifespan. By 2012, these assemblies were standard in desktop computers, embedded controllers, and appliance processors. Thus, there would have been a reasonable expectation of success for combining Chan and Ozturk to achieve predictable improvements in thermal management and operational reliability of Chan's CPU through forced convection cooling.

3. Claim 59: “The appliance according to claim 53, wherein the actuator consists of, or comprises, a thermoelectric actuator and is a heater or a cooler, operative for affecting the temperature of a solid, a liquid, or a gas object, and is coupled to the object by conduction, convection, force convention, thermal radiation, or by the transfer of energy by phase changes.”

455. As discussed, Chan discloses its *appliance module* comprises a “CPU 401” coupled to first sensors (*e.g.*, *current transformer 425b* and *temperature and humidity sensor 409*). (EX1004, [0070], FIG. 4.) In 2012, incorporating a heatsink and fan assembly for CPU cooling was well-known. “The central processing units (CPUs) of computers must be cooled to satisfy the maximum operating temperature limit while removing the heat dissipated by the CPU. Among all the available cooling methods, *forced convection of air* cooling is the most common approach. In this direct heat removal approach, a *fan* is installed to

a heat sink forming an assembly that is attached to the CPU. Air is forced through the heat sink by the fan; thus, the heat is directly transferred to the final heat transfer medium, air.” (EX1014, 650.)

456. A POSITA would have understood (and found it obvious) that a fan is a thermoelectric actuator and cooler, and operative for affecting the temperature of a solid, a liquid, or a gas object by forced convection. “*Heat transfer from a solid body* to a moving agent or within the moving agent is also called convection. Convection may be natural (gravitational) or forced (produced by a mechanism) . . . *Forced convection* of air is produced by a *fan* or blower.” (EX1012, 125.) Here, where the heatsink with fan is incorporated into Chan’s system to for CPU cooling, the fan would be operative for affecting the temperature of the CPU by forced convection. A POSITA would have been motivated to include a fan and heatsink in Chan’s appliance module to cool down and remove heat dissipated by the CPU 401.

457. Further, a POSITA would have understood (and found it obvious) that the fan and heatsink would be coupled to the wireless transceiver for being activated or controlled in response to digital data received from the wireless network. Chan teaches that the appliance module communicates with a gateway via the wireless transceiver to send and receive command or control data. (EX1004, [0008], [0009], [0045], [0046], [0053], [0057], [0073], [0074], [0111].)

Further, Chan's CPU is connected to "Zigbee wireless chipset 405 through a RS232 serial interface. (EX1004, [0070].)

458. A POSITA would have known (and found it obvious) that, because the CPU 401 processes the data and executes commands received through the transceiver, increased computational load resulting from such wireless communication would cause greater heat generation. A POSITA would have recognized that coupling the cooling assembly to the CPU and transceiver would allow the fan speed or operation to increase automatically as the CPU activity rises in response to received digital data, thereby maintaining safe operating temperatures. Such control is predictable and consistent with standard thermal management practices, where fan operation is modulated based on processor workload and system conditions.

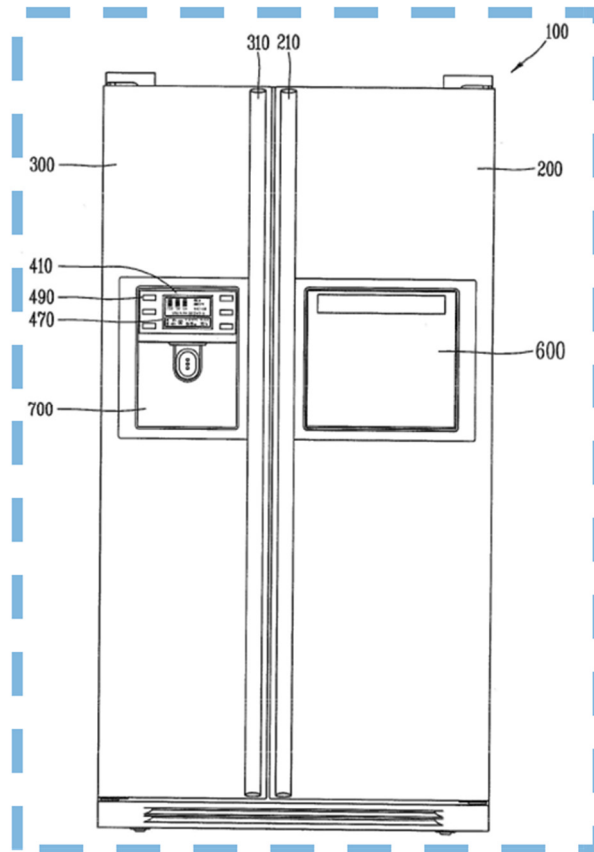
K. Ground 11: Seo in view of Chan Renders Obvious Claims 1, 23, 24, 26, 27, 38, 41, 53, 59

1. Summary of Seo

459. Seo was filed on August 28, 2009, and published July 22, 2010. (EX1005.) It is prior art under 35 U.S.C. §§102(a) and (b). (EX1005.) The Examiner never found, and Applicant never cited, Seo during prosecution. Seo is generally related to a refrigerator control system for "detecting a plurality of interior and exterior states of the refrigerator." (EX1005, [0012]; *see also id.*

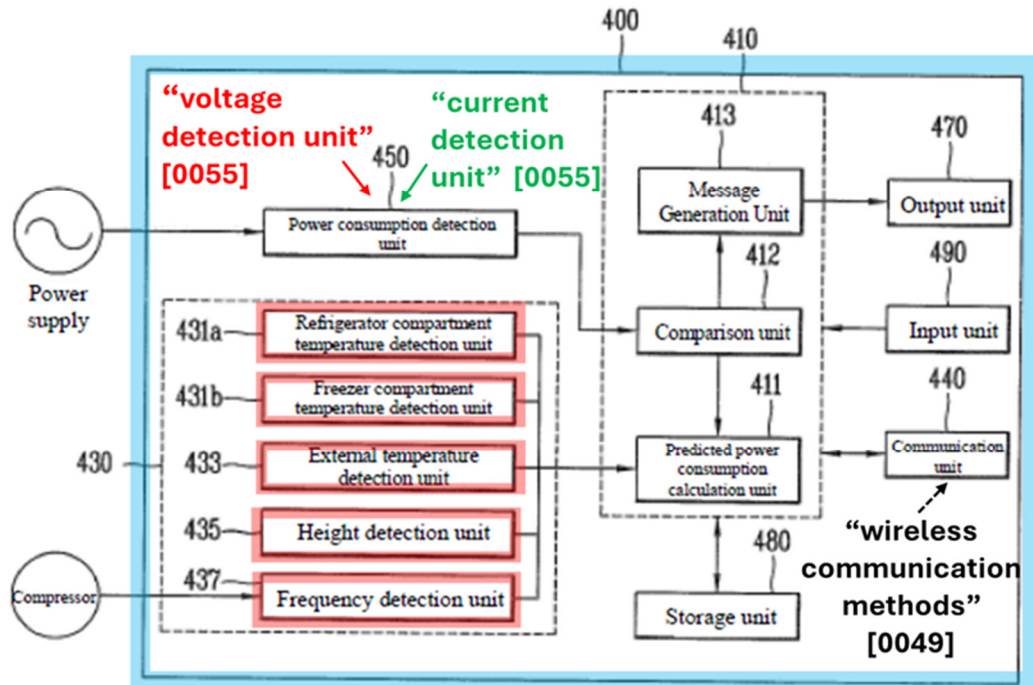
[0089].) Seo discloses a *refrigerator* comprising a control unit 410, as shown in FIG. 1 below. (EX1005, [0012], [0019].)

FIG. 1



460. Control unit 410 is enclosed in a *control device 400* of the *refrigerator*, shown in FIG. 4. The *control device 400* encloses “a power consumption detection unit 450, connected to the *input power source*.” (EX1005, [0054].) The “power consumption detection unit 450 can . . . detect the current . . . applied to the refrigerator main body 100 through a *current detection unit*.” (EX1005, [0055].)

FIG. 4



461. Seo discloses numerous additional sensors, including **"internal temperature detection units (431),"** **"an external temperature detection unit 433,"** **"a gas sensor (not shown),"** a **"a voltage detection unit,"** etc. (EX1005, [0055], [0057]-[0061].) The information obtained by such sensors are used for **"calculating predicted power consumption and usage fees"** and **"generating one or more messages corresponding to the internal and external states."** (EX1005, [0086].)

462. Seo's refrigerator transmits and receives information wirelessly. For example, it **"can transmit and output the data detected, calculated, or generated by the . . . state detection unit 430 to external devices . . . through the communication**

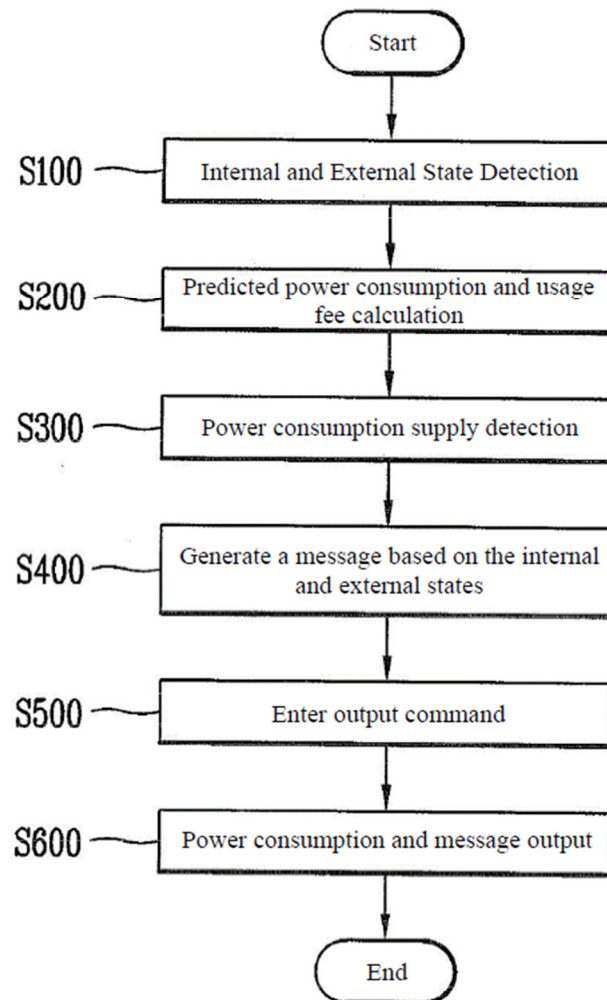
unit.” (EX1005, [0041], [0051].) Seo’s communication unit 440 is connected to external devices (including “mobile phones, “PDA phones,” “monitoring devices”, “remote controllers,” “servers,” “external power devices”) through “*wireless* communication methods such as serial communication, the Internet, ... or wireless LAN.” (EX1005, [0049], [0051].)

463. Seo further describes that the communication unit “transmits to the external device the data detected, calculated, or generated by the control unit 410 or the state detection unit 430,” and “receives various information or control commands from the external device.” (EX1005, [0051], [0126].) In this manner, Seo’s “communication unit 440” establishes a “wireless communication” network between the refrigerator and the “external device,” thereby enabling detection, reporting, and energy-saving control through the network. (EX1005, [0049]-[0051].) Seo explains that detecting and communicating environmental conditions enables better energy analysis and energy saving. (EX1005, [0016].)

464. For example, as shown in FIG. 8, Seo describes a method including “the step for detecting a plurality of internal and external states of the refrigerator S100, a step for calculating predicted power consumption and usage fees based on the detected states S200, a step for generating one or more messages corresponding to the internal and external states S400, and a step for outputting the power consumption and the messages S600.” (EX1005, [0086].)

465. As explained by Seo, “[t]he step for detecting the plurality of states (S100) may include detecting the temperature outside the refrigerator, that is, the room temperature.” (EX1005, [0089].) Further, “the step for outputting S600 transmits the detected, calculated, or generated data as described above to an external device such as a remote controller or a server.” (EX1005, [0099].) For example, “the control method transmits to an external device the consumed power amount in the refrigerator, such as the calculated predicted power consumption or the detected supplied power consumption, the usage fee corresponding to the consumed power amount, the estimated greenhouse gas emissions of the energy source corresponding to the consumed power amount, trends or cumulative statistics of the consumed power amount, usage fee, and estimated greenhouse gas emissions, internal and external state values of the refrigerator such as the amount of stored food and energy saving information, operating information, and messages, and, as necessary, receives various information or control commands from the external device.” (EX1005, [0106].) As explained by Seo, “[t]he external device is connected by ... wireless communication methods such as serial communication, the Internet, ... or wireless LAN.” (EX1005, [0106].)

FIG. 8



466. Seo is analogous to the field of the '590 patent. Both enhance appliance performance through energy monitoring and wireless communication. (EX1001, 62:34-63:18, 82:2-54, 83:39-85:29; EX1005, [0001], [0016].)

2. Motivation to combine Chan and Seo

467. It would have been obvious for a POSITA to combine the appliance control functionality disclosed in Chan with Seo's refrigerator. Both Seo and Chan are analogous to the field of the '590 patent. Each enhances performance of

appliances via energy monitoring and wireless communication. (EX1004, [0041]; EX1005, [0001], [0016].)

468. A POSITA would have been motivated to combine Seo and Chan. Seo itself discloses claim 1 because its refrigerator is already *controlled (e.g., displaying messages, switching energy sources)* based on received data. (*Infra* § IV.B.3.) Further, the Seo-Chan combination provides *more ways to control or activate Seo’s refrigerator*, for example, allowing the refrigerator to receive command data as taught by Seo and/or Chan and “turn the connected appliance on or off” as taught by Chan. (EX1005, [0051]; EX1004, [0057].) By adopting Chan’s teaching, Seo’s refrigerator—already configured for wireless communication—would process command data to operate the refrigerator beyond displaying messages and switching energy sources (*e.g.*, turning the appliance on or off).

469. This combination would expand Seo’s remote-control functionalities (*e.g.*, by enabling on/off switch of the appliance as taught by Chan). (*See* EX1004, [0066].) It would have been obvious to combine Seo and Chan because the known benefits of Chan would prompt its application in the same field based on design incentives and other market forces. *Id.* Moreover, the combination would have required no more than the routine integration of known elements. Seo already includes the necessary hardware/software to control the refrigerator, while

Chan teaches additional ways to control the refrigerator. (EX1005, [0049]-[0051]; EX1004, [0057], [0076], [0110]-[0112].)

470. In addition, Seo emphasizes “user convenience” as a design objective. (EX1004, [0004]). Seo already allows manual user control through its input unit 490, which enables the user to “input a command to output the power amount and the message through the output unit” and to “select one of the energy sources.” (EX1005, [0043]-[0045].) A POSITA would have recognized that incorporating Chan’s wireless command functionality would further enhance user convenience by allowing those same types of control inputs to be performed remotely over the wireless network, rather than requiring physical interaction with the appliance’s local controls.

471. The combination of Chan and Seo would have been straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by successful implementations in the field. Prior art such as Seo and Chan both illustrate the routine and reliable integration of wireless communication modules with appliance control systems to enable remote monitoring and command functionality. By 2012, numerous household appliances (*e.g.*, refrigerators, washers, and thermostats) were commercially equipped with networked control interfaces allowing users to remotely activate, deactivate, or adjust appliance operation through wireless protocols such as Wi-Fi, ZigBee, or Bluetooth. These

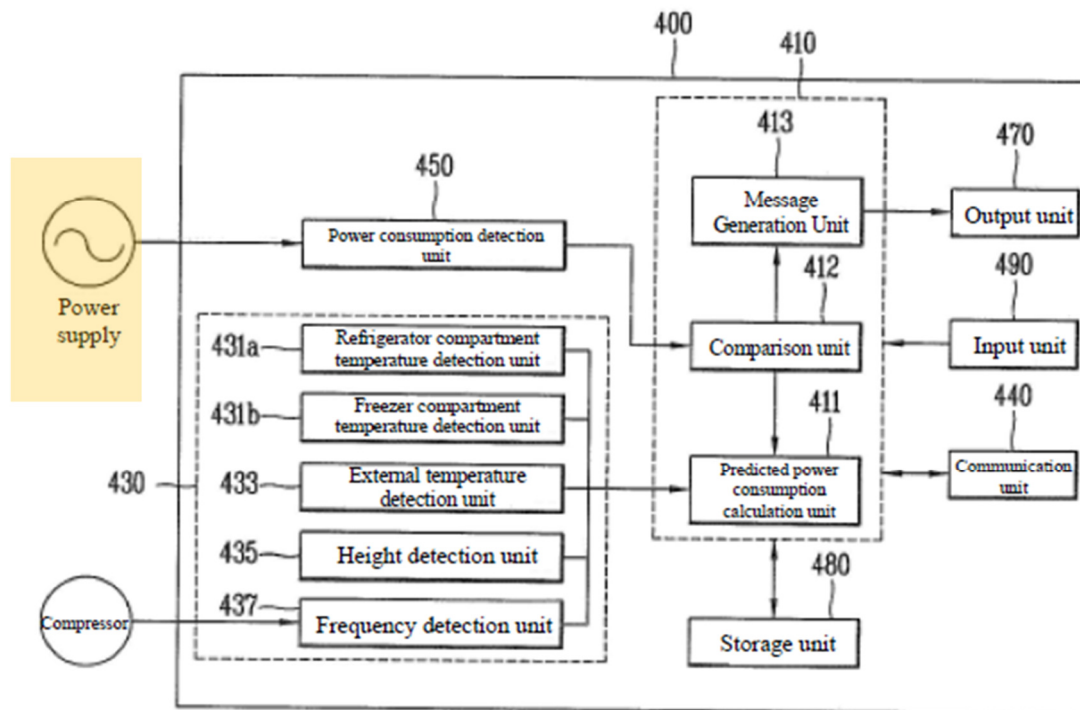
technologies were standardized and well understood, and their integration required no more than routine design optimization. Thus, there would have been a reasonable expectation of success for combining Chan and Seo to achieve predictable improvements in remote appliance control and user convenience by enabling Seo's refrigerator to process and execute wireless command data in the same manner as taught by Chan

3. Claim 1

a. 1[PR1]: “An Alternating-Current (AC) powered appliance”

472. Seo in view of Chan discloses an AC powered appliance. It would have been obvious to a POSITA that Seo's refrigerator—a large household appliance—is AC-powered. (*See e.g.*, EX1004, [0070], [0071], FIG. 4.)

FIG. 4



473. Further, Seo describes “a power consumption detection unit 450, connected to the input power source, for detecting the power consumption supplied to the refrigerator,” and further that the “current . . . applied to the refrigerator main body 100” is detected through a *current detection unit*. (EX1005, [0012], [0054]-[0055], [0022], [0047], [0063], [0094], [0128], Claim 2.) Consistent with that disclosure, FIG. 4 of Seo depicts the input power supply as a sinusoidal waveform, confirming that the refrigerator is powered by alternating current rather than direct current.

474. Although Seo mentions upstream “energy sources” (*e.g.*, fossil fuels, solar, wind, hydro, or nuclear), a POSITA would have understood (and found it

obvious) these energy sources are converted into AC supply suitable for household appliances (*e.g.*, “after going through a transformer.” (EX1005, [0024], [0102].)

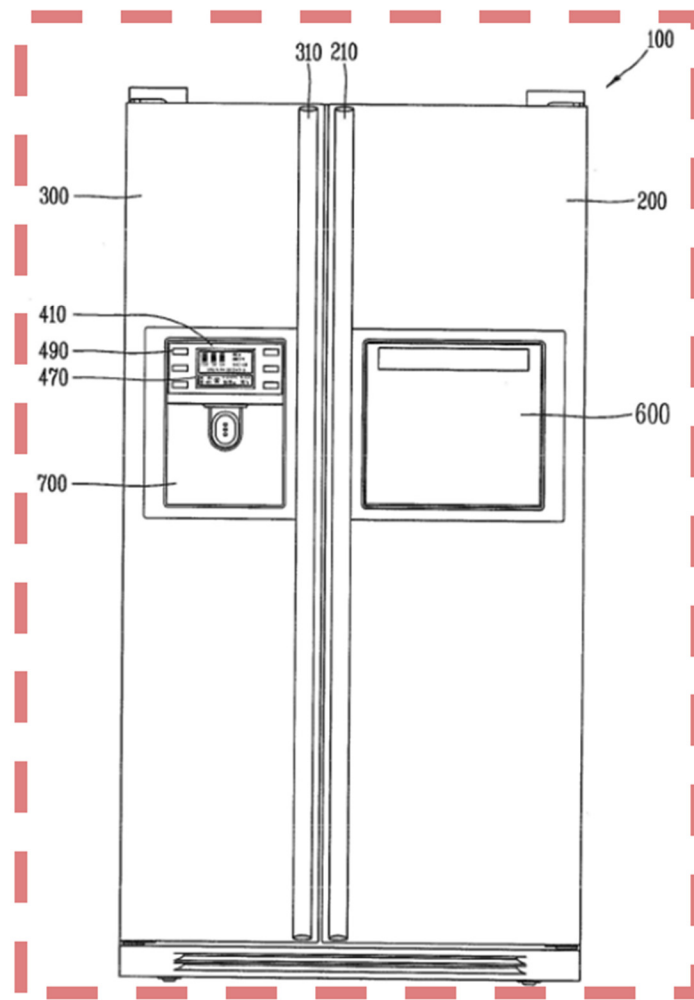
475. Chan also discloses element 1[PR1]. (*Supra* § IX.A.2.a.)

b. 1[PR2]: “associated with a food storage, handling, or preparation,”

476. Seo in view of Chan discloses element 1[PR2].

477. Seo’s “*refrigerator* is an appliance used to keep stored items such as food and beverages fresh over an extended period of time.” (EX1005, [0002], [0003], [0022], [0092].) For example, “[t]he *refrigerator* is operated by the driving of a compressor equipped inside the *refrigerator*. The cold air supplied to the inside of the *refrigerator* is generated by the heat-exchange action of the refrigerant and is continuously supplied to the inside of the *refrigerator* by repeatedly performing the compression-condensation-expansion-evaporation cycle, and the refrigerant supplied to the inside of the *refrigerator* is evenly distributed inside the refrigerator by convection, thereby allowing the food inside the refrigerator to be stored at the desired temperature.” (EX1005, [0003].) Thus, Seo’s *refrigerator* is associated with food storage, handling, or preparation.

FIG. 1



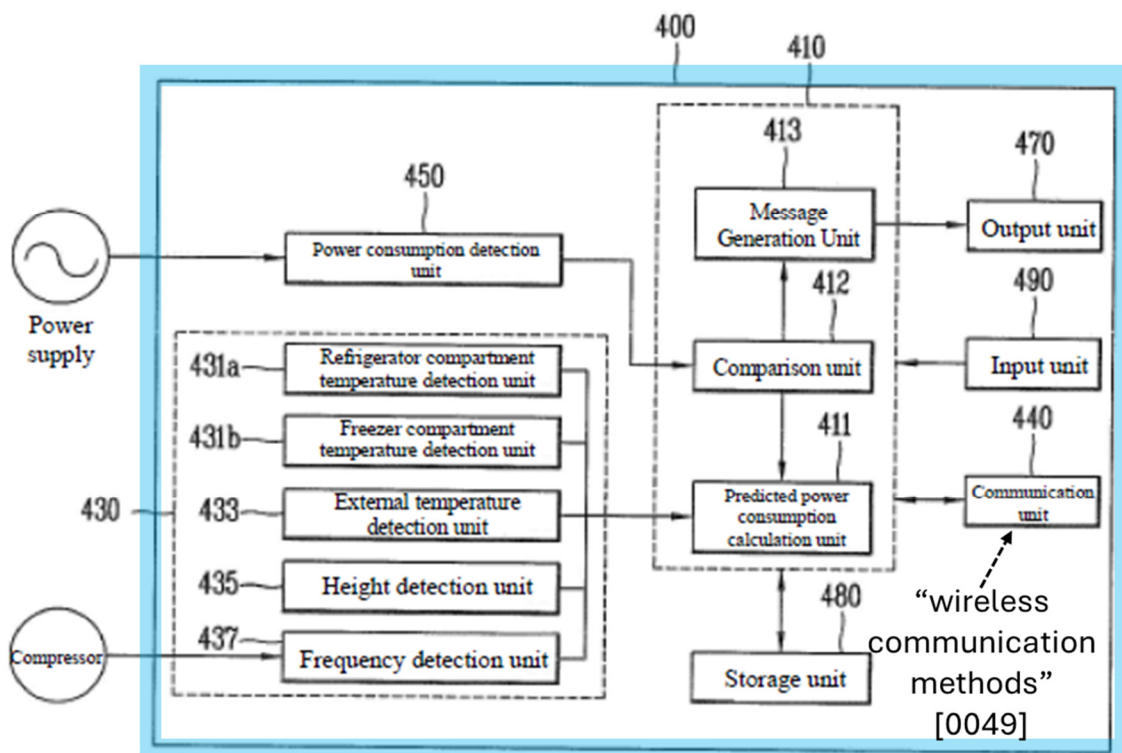
478. Chan also discloses element 1[PR2]. (*Supra* § IX.A.2.b.)

c. 1[PR3]: “for use with a wireless network, the appliance comprising:”

479. Seo in view of Chan discloses element 1[PR3]. In FIG. 4 below, Seo’s *refrigerator* has a *control device 400*, which comprises a “*communication unit 440*.” (EX1005, [0049], [0051], [0081], [0083], FIG. 4.) “The communication unit 440 is connected to the external device by . . . *wireless communication methods*.” (EX1005, [0049], [0051], [0081], [0083], [0104],

[0105], [0124].) Thus, a wireless network is formed by the “external devices” and the *refrigerator*.

FIG. 4

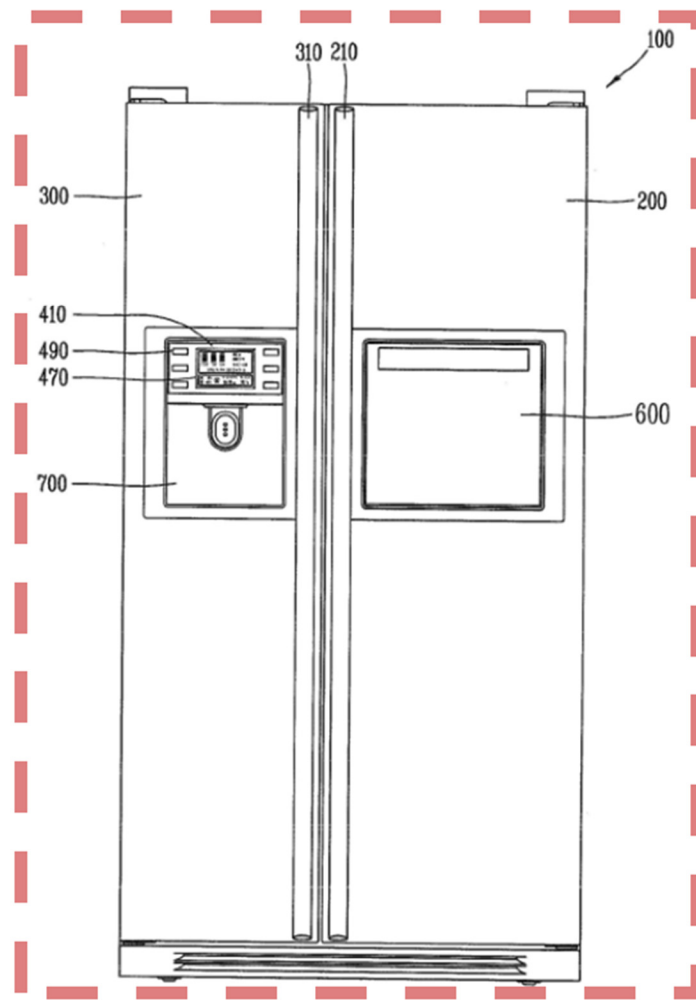


480. Chan also discloses element 1[PR3]. (*Supra* § IX.A.2.c.)

d. 1[A]: “an AC connector for connecting the appliance to an AC power source;”

481. Seo in view of Chan discloses element 1[A]. Seo discloses a *refrigerator* comprising a control unit 410, as shown in FIG. 1 below. (EX1005, [0012], FIG. 1.)

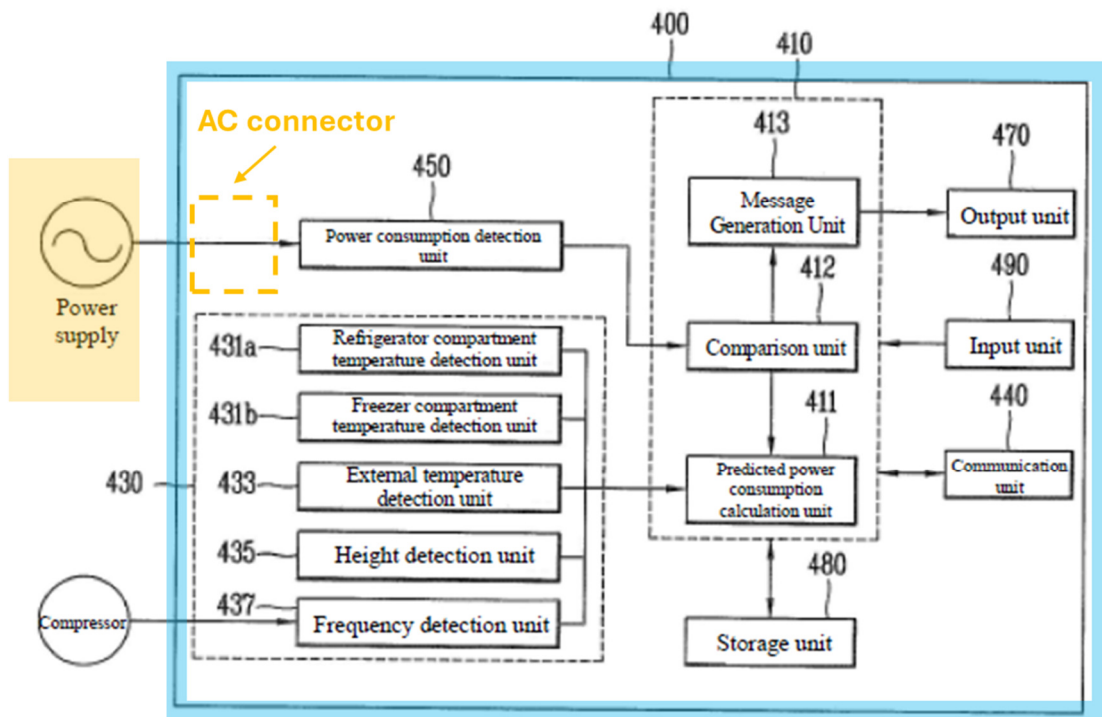
FIG. 1



482. Control unit 410 is enclosed in a *control device 400*, shown in FIG. 4. The device 400 encloses “a power consumption detection unit 450, connected to an *input power source*.” (EX1005, [0012], [0054].) It would have been obvious to a POSITA that Seo’s fridge would comprise an *AC connector* to connect to the *AC input power source* (e.g., the standard electrical wall outlet as disclosed in Chan). (EX1005, [0012], [0054].) It was well-known that a *refrigerator* such as Seo’s has an *AC connector* for connecting to and drawing power from an *AC input power*

source (e.g., the standard electrical wall outlet as disclosed in Chan). (EX1004, [0012], [0054].)

FIG. 4



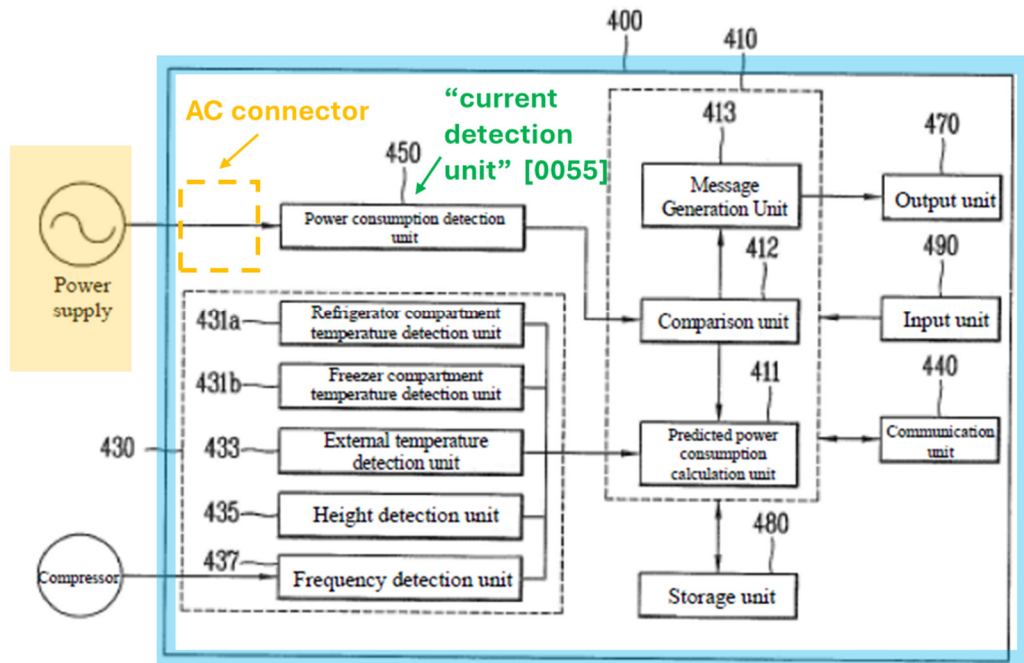
483. Chan also discloses element 1[A]. (*Supra* § IX.A.2.d.)

e. **1[B]: “a current sensor coupled to the AC connector for measuring an AC current consumed by the appliance;”**

484. Seo in view of Chan discloses element 1[B]. Seo’s “power consumption detection unit 450 can . . . detect the current . . . applied to the refrigerator main body 100 through a *current detection unit*.” (EX1005, [0047], [0055], [0128].) A *current detection unit* that detects current applied to the refrigerator is a *current sensor* that measures current consumed by the appliance. The *current detection unit* is coupled to an *AC connector* because “power

consumption detection unit 450 [comprising the *current detection unit*] [is] connected to an input power source [i.e., via the *AC connector* of the refrigerator].” (EX1005, [0012], [0054], [0055].)

FIG. 4



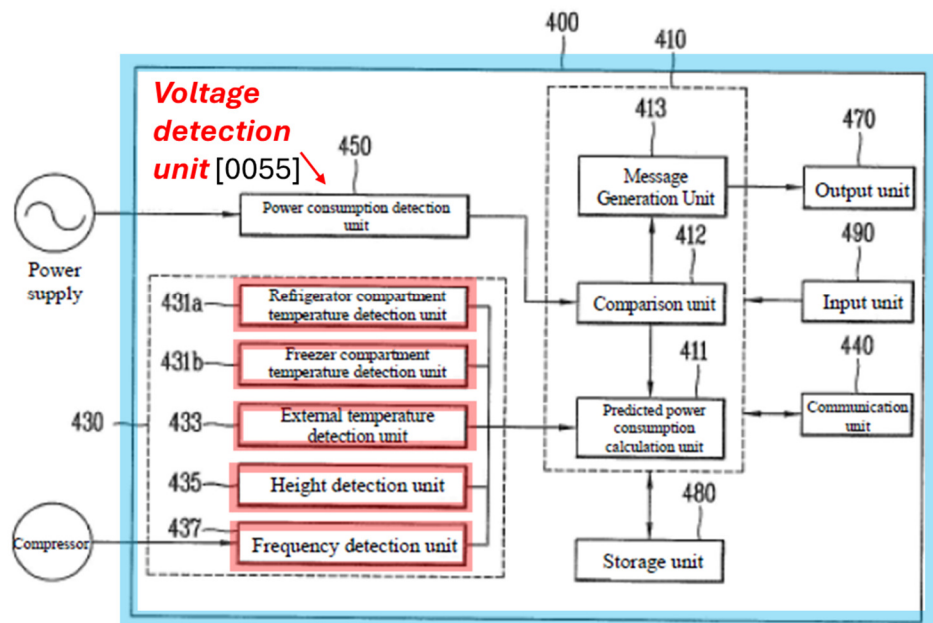
485. Chan also discloses element 1[B]. (*Supra* § IX.A.2.e.)

f. 1[C]: “a first sensor having an output that responds to a physical phenomenon;”

486. Seo in view of Chan discloses element 1[C]. Seo discloses numerous such first sensors in the control device 400. For example, Seo describes “the state detection unit 430 may include one or more *internal temperature detection units* (431),” “an *external temperature detection unit 433*,” and “a *gas sensor* (not shown) that detects greenhouse gases such as carbon dioxide generated from the

refrigerator itself.” (EX1005, [0057]-[0061], [0012], [0020]-[0022], [0027]-[0031].) Seo also discloses that “[t]he power consumption detection unit 450 can ... detect the ... voltage applied to the refrigerator main body 100 through ... a *voltage detection unit*.” (EX1005, [0047], [0055].) Further, “the refrigerator control device (400) . . . may further include a *sensor* (not shown) that *detects the opening and closing of the door*.” (EX1005, [0071].) All of these sensors have outputs that respond to physical phenomena. (See, e.g., EX1001, 16:44-50; 22:25-34.)

FIG. 4

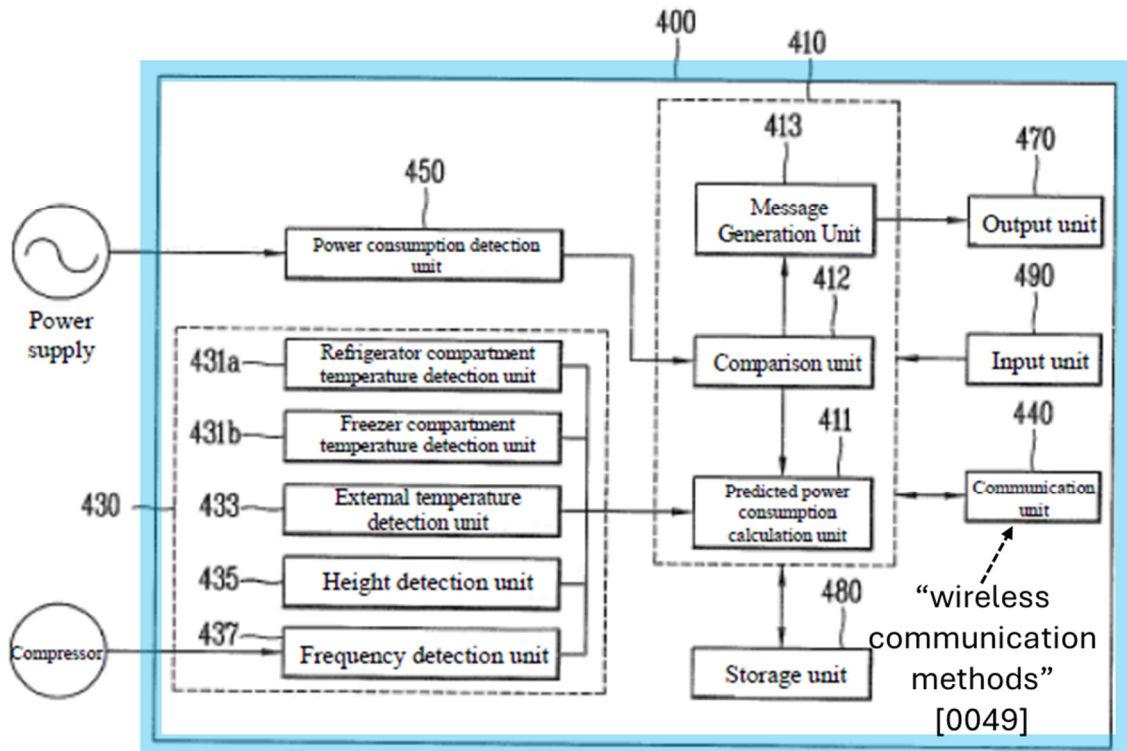


487. Chan also discloses element 1[C]. (Supra § IX.A.2.f.)

g. 1[D]/1[E]: “an antenna for communication over the wireless network; a wireless transceiver coupled to the antenna for transmitting digital data to, and for receiving digital data from, the wireless network; and;”

488. Seo in view of Chan discloses elements 1[D]/1[E]. Seo teaches an *antenna* coupled to a *wireless transceiver* for communication over the wireless network. For example, as shown in FIG. 4, the control device 400 includes a “communication unit 440 [that] is connected to the external device by ... *wireless* communication methods.” (EX1005, [0049], [0051], [0081], [0083], [0104], [0106].) A POSITA would have understood (and found it obvious) that the communication unit 440 includes an *antenna* coupled to a *wireless transceiver* for enabling wireless communication. (EX1018, 369.) It was well-known that “wireless communication requires a *transmitter* (*transmitter electronics* plus *antenna*) . . . [and] a *receiver* (*receiving electronics* plus *antenna*).” EX1018, 369; EX1022, 3:17-20, 3:38-40; EX1023, [0013]-[0015].) A “*transceiver* consists of a *transmitter* and a *receiver*.” *Id.*

FIG. 4



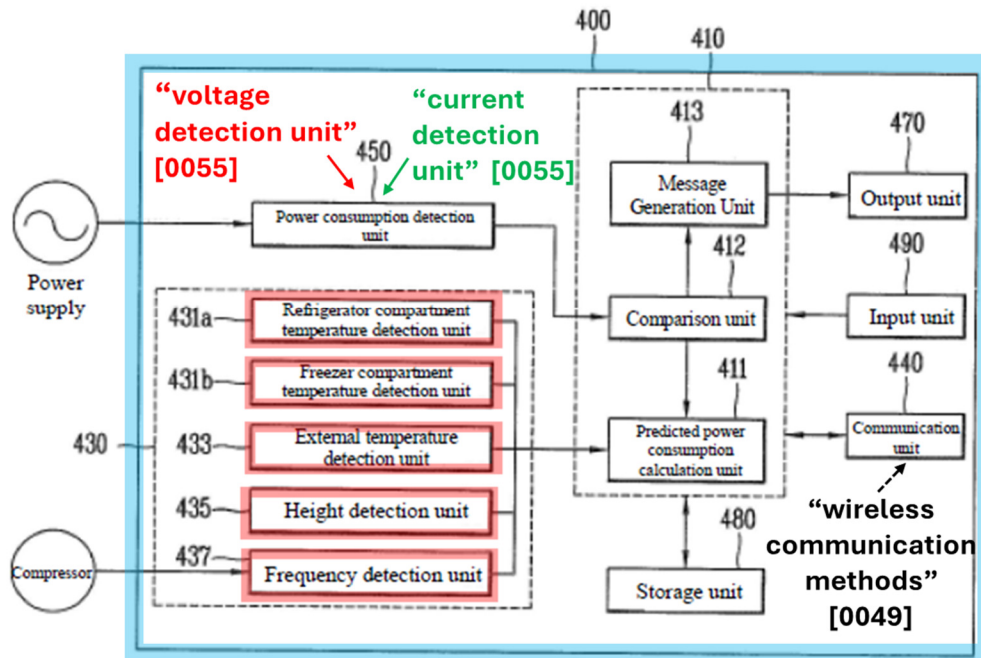
489. Seo further teaches the wireless transceiver is for **transmitting** digital data to, and for **receiving** digital data from, the wireless network. Seo's communication unit 440 (including the **wireless transceiver**) is "connected to an external power device and **exchanges** information therewith." (EX1005, [0049], [0081].) Seo's communication unit both "**transmits** to the external device [*e.g.*, "mobile phones," "PDA phones," "remote controllers," "external power device," etc.] the data detected, calculated, or generated by the control unit 410 or the state detection unit 430" and "**receives** various information or control commands." (EX1005, [0049], [0051], [0081], [0083].)

490. Chan also discloses elements 1[D]/1[E]. (Supra § IX.A.2.g.)

h. 1[F]: “a single enclosure housing the current sensor, the first sensor, the antenna, and the wireless transceiver,”

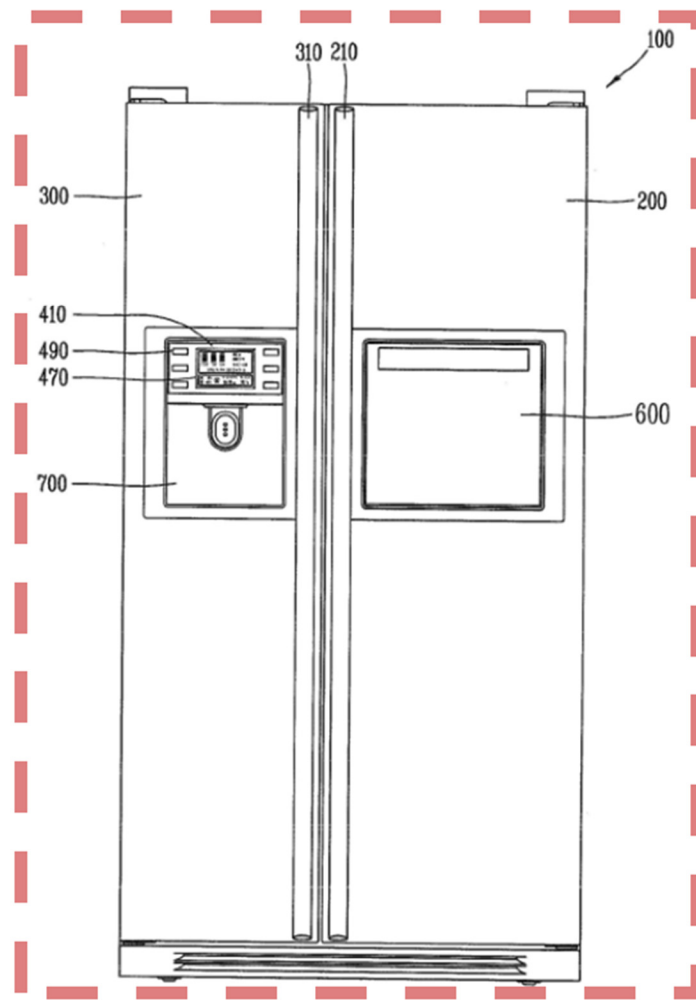
491. Seo in view of Chan discloses element 1[F]. FIG. 4 of Seo expressly shows that the *control device 400* encloses the power consumption detection unit 450 (including “*current detection unit*”), the various *first sensors*, and the communication unit 440 (including the *wireless transceiver* and *antenna*). (EX1005, [0054]-[0057], FIG. 4.) Seo describes the *control device 400* as a “device.” (EX1005, [0016], [0054], [0081].) For example, the “refrigerator [is] provided with a refrigerator control device,” which “includes a state detection unit 430... a power consumption unit 450” and “a communication unit 440.” (EX1005, [0016], [0054], [0081].) A POSITA would have understood (and found it obvious) that the *control device 400*, as a device, would have a device housing enclosing its parts.

FIG. 4



492. Additionally, the *refrigerator* itself is also a single enclosure. As shown in FIG. 1, the *refrigerator* has an outer shell ("main body 100") enclosing its parts including the claimed elements. (EX1005, [0019], [0047], [0055], FIG. 1.)

FIG. 1



493. Chan also discloses element 1[F]. (*Supra* § IX.A.2.h.)

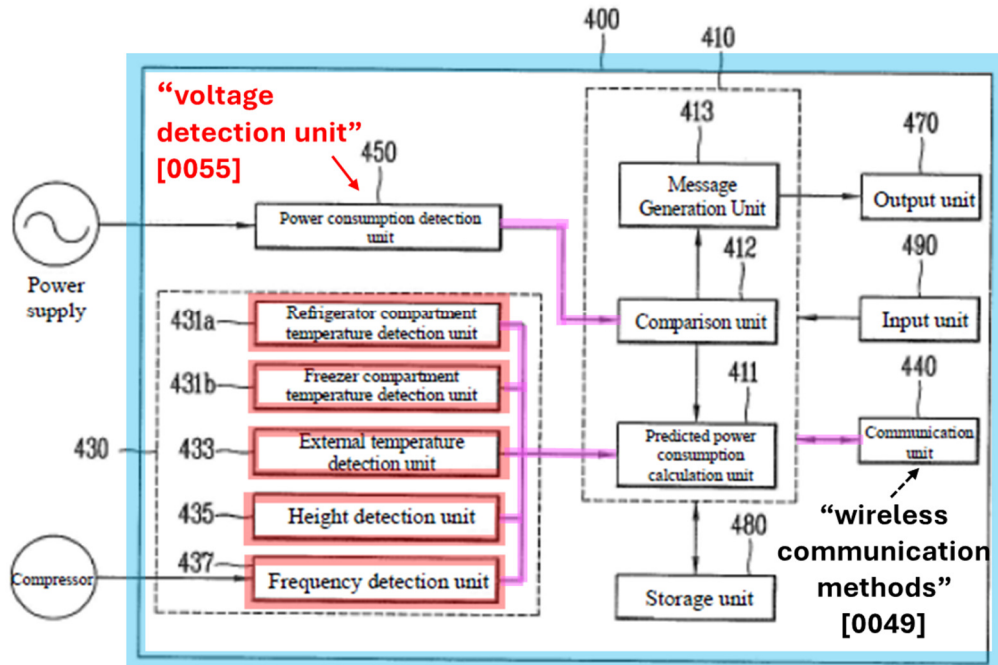
i. 1[G]: “wherein the first sensor is coupled to the wireless transceiver for transmitting digital data in response to the physical phenomenon to the wireless network,”

494. Seo in view of Chan discloses element 1[G].

495. First, Seo discloses that the *first sensor* is *coupled* to the wireless transceiver. As described above, Seo includes *sensors* that have outputs responding to physical phenomenon. (EX1005, [0012], [0055]-[0061], [0071]; *see*

also *supra*, IX.B.3.f.) In FIG. 4 below, the control device 400 includes a communication unit 440 (including a *wireless transceiver*) *coupled to* various *physical phenomenon sensors*. (EX1005, FIG. 4.)

FIG. 4



496. Seo discloses that the *wireless transceiver transmits digital data in response to* the measured physical phenomenon. The *first sensors* are part of the “state detection unit 430” and they monitor physical phenomenon (*e.g.*, the fridge’s “internal and external states”), such as temperature (*e.g.*, by the “internal temperature detection units (431)” or “external temperature detection unit 430”), greenhouse gases (*e.g.*, by the “gas sensor”), dimensions (*e.g.*, by the “height detection units 435”), etc.). (EX1005, [0021]-[0031], [0054]-[0062].)

497. Seo's communication unit 440 transmits ***digital data*** in response to the internal and external states ("physical phenomenon"). "The communication unit 440 ***transmits*** to the external device ***the data detected, calculated, or generated*** by the . . . ***state*** detection unit 430." (EX1005, [0051], [0083].) For example:

The communication unit 440 ***transmits*** the consumed power amount of the refrigerator, such as the calculated predicted power consumption or the ***detected supplied power consumption***, the usage fee corresponding to the consumed power amount, ***the estimated greenhouse gas emissions of the energy source corresponding to the consumed power amount***, trends or cumulative statistics of the consumed power amount, ***estimated greenhouse gas emissions***, and usage fee, ***internal and external state values of the refrigerator*** such as the amount of stored food and energy saving information, operating information, and messages. (EX1005, [0051], [0083].)

498. Seo also teaches that such data is transmitted via the ***wireless*** network. For example, Seo's "communication unit 440 is connected to the external device by wired ***or wireless communication methods*** such as serial communication, the Internet, power line communication, or wireless LAN." (EX1005, [0051].)

499. To the extent that the claim requires the detection of physical phenomenon to trigger the data transmission (which is not conceded), it would have been obvious to a POSITA that Seo discloses or at least suggests this. For example, Seo states “control unit 410 further includes a comparison unit 412 that *compares* the [detected] internal and external states with the preset reference states, and a message generation unit 413 that generates one or more messages corresponding to the internal and external states based on the comparison results.” (EX1005, [0035].) Further, communication unit 440 “*transmits* to the external device the data detected, calculated, or generated by the control unit 410.” (EX1005, [0051].) Thus, it would have been obvious that, for example, upon detection of a state value exceeding a threshold (*e.g.*, when the temperature, door-open time, or gas concentration deviates from a set condition) the control unit 410 would transmit information for real-time reporting and remediation.

500. Thus, Seo teaches a variety of *sensors* that measure data related to physical phenomena and whose measurements are transmitted wirelessly by the communication unit 440 (including a *wireless transceiver*) to an external device for analysis and control.

501. Chan also discloses element 1[G]. (*Supra* § IX.A.2.i.)

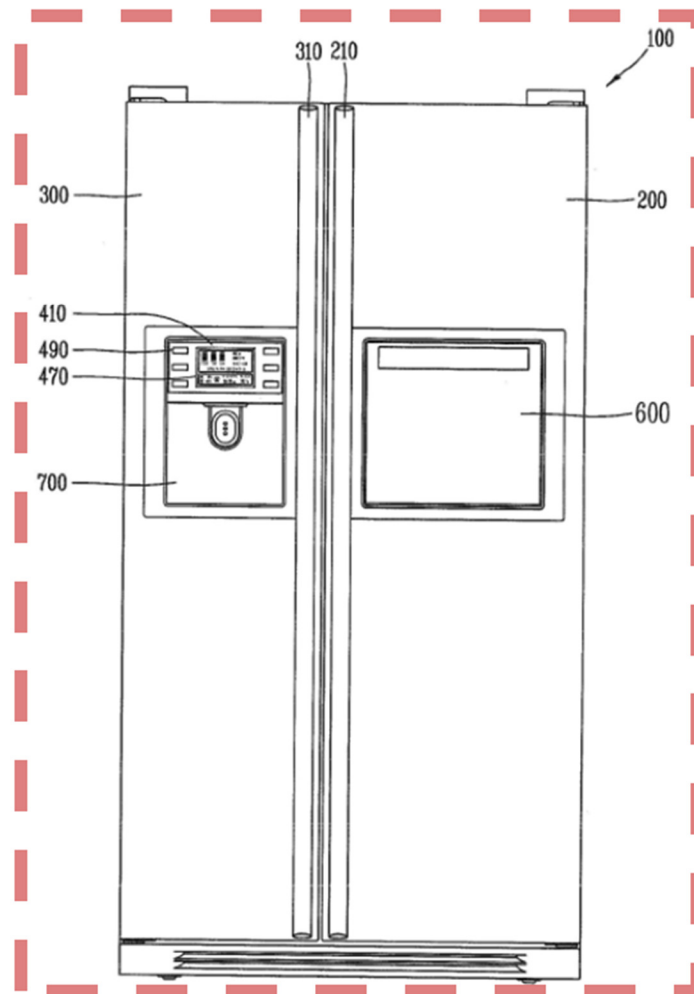
j. 1[H]: “wherein the appliance is controlled or activated in response to digital data received from the wireless network, and;”

502. Seo in view of Chan discloses element 1[H].

503. First, Seo discloses that the *refrigerator* is controlled or activated.

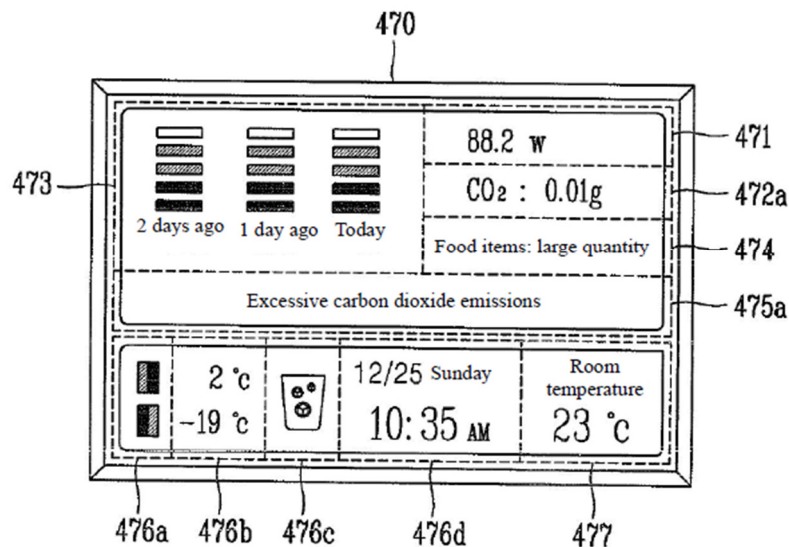
Seo's *refrigerator* includes an "output unit 470 [that] includes a screen display unit that outputs the power consumption and the corresponding usage fees." (EX1005, [0040], [0043], [0073], [0074].) The '590 patent explains that a display is an actuator. "An actuator may be a display for presentation of visual data or information, commonly on a screen." (EX1001, 25:33-37.)

FIG. 1



504. The control/activation of the display is *in response to digital data received from the wireless network*. For example, “the *control device* can receive, through the communication unit 440, information such as the type of energy source and *the greenhouse gas index* corresponding to the energy source from the external power device.” (EX1005, [0049], [0104].) The “the control unit 410 calculates the *estimated greenhouse gas emissions* . . . by multiplying the *carbon dioxide index* of the energy source by the predicted power consumption or the supplied power consumption” and “the output unit 470 *displays* the calculated predicted power consumption and *the corresponding greenhouse gas emissions* and usage fees.” (EX1005, [0040], [0065], [0102].) As shown in FIG. 7, “when the currently supplied energy source is expected to produce a high amount of greenhouse gases . . . messages such as ‘Carbon dioxide emissions are high’ or ‘Please switch to a different energy source’ are generated.” (EX1005, [0067].)

FIG. 7



505. In other words, the control device wirelessly receives a ***greenhouse gas index*** from an external device, calculates expected greenhouse gas emission ***based on the greenhouse gas index***, then controls the display to output the calculated expected greenhouse gas emission and associated messages. Thus, Seo's fridge is controlled ***in response to*** data wirelessly received from the external device.

506. Seo's refrigerator is also controlled to switch types of energy source in response to received data. "[T]he control device may replace the energy source with one having a relatively lower greenhouse gas index when the ***estimated greenhouse gas emissions*** exceed, or are expected to exceed, a certain amount while the refrigerator is operating using a fossil fuel as the energy source." (EX1005, [0045].) Thus, the control device 400 receives energy source

information wirelessly, uses that data to calculate expected greenhouse-gas emissions, and automatically switches to a different type of energy source accordingly.

507. As another example, “the communication unit 440 is connected between the output unit 470 and an external device” and “receives various information or control commands.” (EX1005, [0051].) An example of such an external device is a “remote controller[.]” (EX1005, [0051], [0075], [0083], [0099], [0106], [0120], [0126].) A POSITA would have understood (and found it obvious) that these received “control commands” would be used by the control unit 410 to perform corresponding control or activation actions within the refrigerator system.

508. Further, the Seo-Chan combination also discloses this. For example, Chan discloses that the appliance is turned on or off in response to digital data received from the wireless network. (*Supra* § IX.A.2.j.) In the combined system, the refrigerator would receive “commands,” as taught by Seo and/or Chan, and operate accordingly (*e.g.*, “turning the connected appliance on or off” as taught by Chan). (EX1005, [0051]; EX1004, [0057].) A POSITA would have been motivated to combine Chan’s additional control features (*e.g.*, turning the appliance on and off and other control features) with Seo to achieve known benefits of expanding controllable features of Seo.

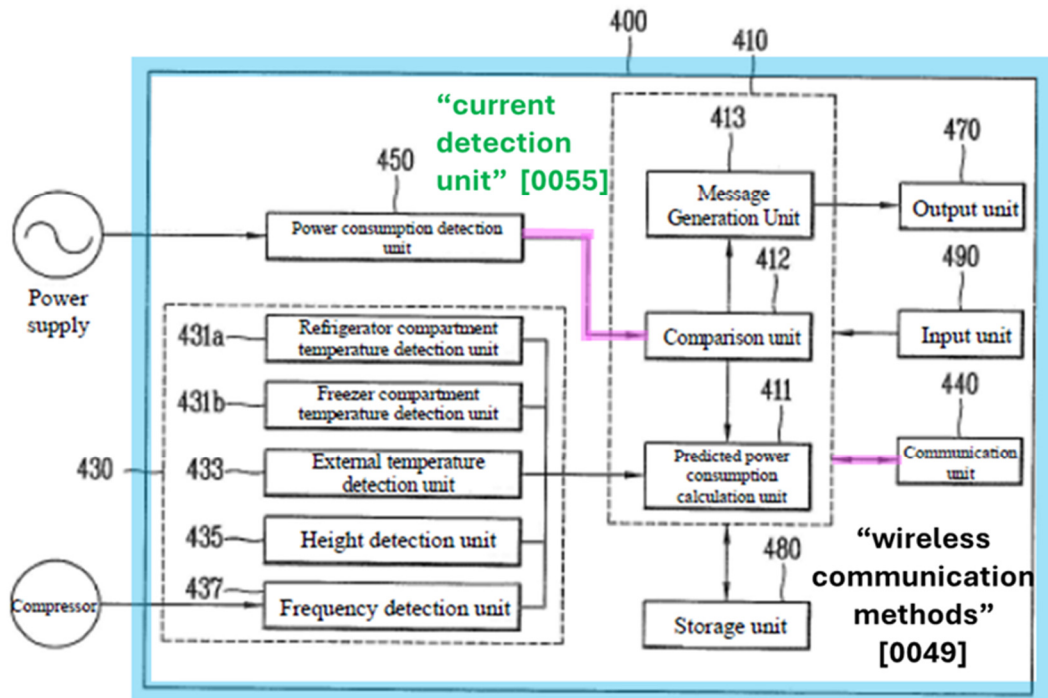
509. Chan also discloses element 1[H]. (*Supra* § IX.A.2.j.)

k. 1[I]: “wherein the current sensor is further coupled to the wireless transceiver for transmitting digital data in response to the measured AC current to the wireless network.”

510. First, Seo describes *the current sensor is coupled to* the *wireless transceiver* for transmitting digital data in response to the measured AC current to the wireless network. As described above, Seo describes a refrigerator-control system for “detecting a plurality of states inside and outside the refrigerator,” including include “a power consumption detection unit 450, connected to the input power source, for detecting the power consumption supplied to the *refrigerator*.” (EX1005, [0054].) Seo discloses that the “power consumption detection unit 450 can detect power consumption in various ways; for example, it may detect the current and voltage applied to the *refrigerator main body 100* through a *current detection unit* (not shown).” (EX1005, [0055].)

511. As shown in FIG. 4, the *control device 400* includes a communication unit 440 (including a *wireless transceiver*) *coupled to* the power consumption unit 450 (including the *current detection unit*). (EX1005, FIG. 4.)

FIG. 4



512. Second, the *wireless transceiver* transmits digital data in response to the measured AC current. For example, “the communication unit 440 [comprising the *wireless transceiver*] *transmits* the consumed power amount, including the *predicted power consumption* calculated in the refrigerator or *the supplied power consumption detected.*” (EX1005, [0083].) As discussed previously, the “power consumption detection unit 450 can detect power consumption in various ways; for example, ... through a *current detection unit.*” (EX1005, [0055]; EX1020, 10.)

513. Such data is transmitted via the *wireless* network. For example, Seo’s communication unit 440 sends such data using “*wireless* communication methods such as ... the Internet ... or wireless LAN.” (EX1005, [0051].)

514. Chan also discloses element 1[I]. (*Supra* § IX.A.2.k.)

4. Claim 23: “The appliance according to claim 1, wherein the wireless network is a Wireless Local Area Network (WLAN), the antenna is a WLAN antenna, and the wireless transceiver is a WLAN modem.”

515. Seo discloses the wireless network is a Wireless Local Area Network (WLAN), the antenna is a WLAN antenna, and the wireless transceiver is a WLAN modem.

516. First, Seo discloses the wireless network is a WLAN. Seo’s “communication unit 440 is connected to the external device by wired or wireless communication methods such as . . . wireless LAN.” (EX1005, [0051].)

517. Second, Seo discloses the antenna is a WLAN antenna and the wireless transceiver is a WLAN modem. It would have been obvious to a POSITA that the communication unit includes a WLAN transmitter and receiver (*i.e.*, a WLAN transceiver) to enable WLAN functionality. (EX1004, [0008], [0073].)

518. As discussed, it was well-known that “one-way (simplex) wireless communication requires a *transmitter* (*transmitter electronics* plus *antenna*) generating (electromagnetic) signals that can be properly received and deciphered by a *receiver* (*receiving electronics* plus *antenna*.) Bidirectional communication requires a pair of *transceivers*—each *transceiver* consists of a *transmitter* and a *receiver*.” (EX1018, 369.) Further, WLAN devices equipped with WLAN

transceiver and WLAN antenna for “send[ing] and receiv[ing] suitable information via a WLAN protocol” are well-known. (EX1022, 3:17-20, 3:38-40; see also, EX1023, [0013]-[0015].) Thus, a POSITA would have understood (and found it obvious) that to enable *WLAN communication*, the control device and communication unit would include a *WLAN transceiver (modem)* and a *WLAN antenna*. (EX1018, 369.)

519. Chan also discloses this claim. (Supra §IX.A.17.)

5. Claim 24: “The appliance according to claim 23, wherein the WLAN is according to, based on, or compatible with, IEEE 802.11-2012, IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, IEEE 802.11n, or IEEE 802.11ac.”

520. Seo discloses the WLAN is according to, based on, or compatible with, IEEE 802.11a, IEEE 802.11b, or IEEE 802.11g. As discussed above, Seo’s “communication unit 440 is connected to the external device by wired or wireless communication methods such as . . . wireless LAN.” (EX1005, [0051].)

521. A POSITA would have understood (and found it obvious) that WLAN is based on the IEEE 802.11 standards which include the 802.11a/b/g family. For example, Goldsmith discloses that “[w]ireless local area networks (*WLANs*) are built around the family of *IEEE 802.11 standards* . . . *The 802.11a/b/g family* of standards are collectively referred to as *Wi-Fi*, for wireless fidelity.” (EX1009, 558-559.) “*Wi-Fi* is a registered trademark owned by the Wi-Fi Alliance, and it

refers to *wireless local area network (WLAN)* products that are based on the Institute of Electrical and Electronics Engineers' (*IEEE*) *802.11 standards*." (EX1021, 7:48-51.) This is consistent with the description of the '590 patent which states that "[i]n order to allow interoperability between equipment manufactured by different vendors, few *WLAN standards* have evolved, as part of the *IEEE 802.11 standard group, branded as WiFi* (www.wi-fi.org). IEEE 802.11b describes a communication using the 2.4 GHz frequency band and supporting communication rate of 11 Mb/s, IEEE 802.11a uses the 5 GHz frequency band to carry 54 MB/s and IEEE 802.11g uses the 2.4 GHz band to support 54 Mb/s." (EX1001, 8:25-32.)

522. Thus, Seo discloses a wireless network based on WLAN that is according to, based on, or compatible with IEEE 802.11a, IEEE 802.11b, IEEE 802.11g.

523. Chan also discloses this claim. (Supra §IX.A.18.)

6. Claim 26: "The appliance according to claim 1, wherein the wireless network uses a licensed or unlicensed radio frequency band."

524. Seo discloses the wireless network uses unlicensed radio frequency bands. As discussed, Seo's "communication unit 440 is connected to the external device by wired or wireless communication methods such as . . . wireless LAN." (EX1005, [0051].)

525. A POSITA would have understood (and found it obvious) that WLAN over 802.11b and 802.11g are unlicensed radio frequency bands. For example, Goldsmith discloses that “[m]any extremely successful wireless systems operate in *unlicensed bands*, including *wireless LANs*, Bluetooth, and cordless phones.” (EX1009, 21.) Further, Goldsmith summarized in the table below regarding “unlicensed radio frequency spectrum allocations in the U.S.” that the spectrums include 2.4-2.4835 GHz and 5.15-5.25 GHz, covering 802.11b WLANs and 802.11a WLANs. (EX1009, 18-19, 23.)

Table 1.2: Unlicensed U.S. spectrum allocations	
Band	Frequency
ISM band I (cordless phones, 1G WLANs)	902–928 MHz
ISM band II (Bluetooth, 802.11b and 802.11g WLANs)	2.4–2.4835 GHz
ISM band III (wireless PBX)	5.725–5.85 GHz
U-NII band I (indoor systems, 802.11a WLANs)	5.15–5.25 GHz
U-NII band II (short-range outdoor systems, 802.11a WLANs)	5.25–5.35 GHz
U-NII band III (long-range outdoor systems, 802.11a WLANs)	5.725–5.825 GHz

526. Further, “[w]ireless networks operate today in what are called unlicensed frequencies . . . The common public *unlicensed frequency bands* (in the United States) are 900 MHz, 2.4 GHz, and 5.1 GHz . . . *802.11b, 802.11g, and 802.11n networks* are operate in the 2.4-GHz band.” (EX[DOHERTY], 229-230.)

527. Thus, Seo’s “communication unit,” uses unlicensed frequency bands.

528. Chan also discloses this claim. (Supra §IX.A.20.)

7. Claim 27: “The appliance according to claim 26, wherein the unlicensed radio frequency band is an Industrial, Scientific and Medical (ISM) radio band.”

529. Seo discloses the wireless network uses unlicensed *ISM* radio frequency bands. As discussed, Seo’s “communication unit 440 is connected to the external device by wired or wireless communication methods such as . . . wireless LAN.” (EX1005, [0051].)

530. A POSITA would have understood (and found it obvious) that WLAN over 802.11b and 802.11g communicate using *ISM* radio bands. (EX1009, 18-19, 23, Table 1.2.)

Table 1.2: Unlicensed U.S. spectrum allocations	
Band	Frequency
ISM band I (cordless phones, 1G WLANs)	902–928 MHz
ISM band II (Bluetooth, 802.11b and 802.11g WLANs)	2.4–2.4835 GHz
ISM band III (wireless PBX)	5.725–5.85 GHz
U-NII band I (indoor systems, 802.11a WLANs)	5.15–5.25 GHz
U-NII band II (short-range outdoor systems, 802.11a WLANs)	5.25–5.35 GHz
U-NII band III (long-range outdoor systems, 802.11a WLANs)	5.725–5.825 GHz

531. Thus, Seo’s “communication unit,” uses unlicensed frequency bands.

532. Chan also discloses this claim. (Supra §IX.A.21.)

8. Claim 38: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, an atmospheric or an environmental sensor.”

533. Seo discloses the first sensor consists of, or comprises, an atmospheric or an environmental sensor. Seo describes a number of sensors. For example,

Seo's "state detection unit 430 may include one or more internal temperature detection units 431 that detect the temperature within one or more storage compartments provided inside the refrigerator," "an external temperature detection unit 433 that detects the temperature outside the refrigerator, that is, the room temperature," and "a gas sensor (not shown) that detects greenhouse gases, such as carbon dioxide, generated within the refrigerator itself." (EX1005, [0027]-[0031].)

534. A POSITA would have understood (and found it obvious) that such sensors are environmental sensors that sense environmental data. This is consistent with the '590 patent, which discloses "A sensor may respond to *environmental* conditions such as *temperature*, humidity, noise, vibration, *fumes*, odors, toxic conditions, dust, and ventilation." (EX1001, 63:57-59; *see also* 65:18-20 ("The environmental related sensor may respond to humidity, air pressure, and *air temperature*.").)

535. Chan also discloses this claim. (Supra §IX.A.25.)

9. Claim 41: "The appliance according to claim 1, wherein the first sensor consists of, or comprises, a photoelectric sensor that responds to a visible or an invisible light, and wherein the invisible light is infrared, ultraviolet, X-rays, or gamma rays."

536. Seo discloses the first sensor consists of, or comprises, a photoelectric sensor that responds to an invisible light, and wherein the invisible light is infrared.

Seo's "state detection unit 430 may include one or more height detection units 435 that ... may use a pair of infrared sensors including a transmitter and a receiver." (EX1005, [0029].) Such infrared sensors are photoelectric sensors that respond to *invisible, infrared* light.

537. A POSITA would have understood (and found it obvious) that an infrared *sensor* consists of or comprises a photoelectric sensor that responds to a visible or an invisible light. "Detectors of electromagnetic radiation in the spectral range from *ultraviolet* to far infrared are called light detectors." (EX1012, 461.) "The process of optical detection involves the direct conversion of optical energy (in the form of photons) into an electrical signal (in the form of electrons)." (EX1012, 466.)

538. Chan also discloses this claim. (Supra §IX.A.26.)

10. Claim 53: "The appliance according to claim 1, further comprising in the single enclosure an actuator for affecting the physical phenomenon, wherein the actuator is coupled to the wireless transceiver for being activated or controlled in response to digital data received from the wireless network."

539. Seo discloses an actuator in the single enclosure for affecting the physical phenomenon, wherein the actuator is coupled to the wireless transceiver for being activated or controlled in response to digital data received from the wireless network.

540. Seo's "*refrigerator*" is operated by the driving of a *compressor* equipped *inside the refrigerator* [e.g., the *single enclosure*]." (EX1005, [0003].) The compressor "allow[s] the food inside the refrigerator to be stored at the desired temperature [e.g., affecting the physical phenomenon (temperature)]." (EX1005, [0003]; *see also* EX1001, 41:23-32, 97:18-26.)

541. As discussed previously, Seo-Chan's communication unit 440 (including a *wireless transceiver*) wirelessly receives digital data for controlling the refrigerator. (*Supra*, IX.K.3.j.) It would have been obvious to a POSITA that such wireless control functionality includes *temperature control* since Seo's state detection unit 430 already measures internal temperatures and is coupled to the compressor to detect drive parameters. (EX1005, [0040], [0064], FIG. 4.) To enable such functionality, a POSITA would have understood (and found it obvious) the compressor to be *coupled to the wireless transceiver* for being controlled in response to digital data received from the wireless network.

542. Chan also discloses this claim. (*Supra* §IX.A.30.)

11. Claim 59: "The appliance according to claim 53, wherein the actuator consists of, or comprises, a thermoelectric actuator and is a heater or a cooler, operative for affecting the temperature of a solid, a liquid, or a gas object, and is coupled to the object by conduction, convection, force convection, thermal radiation, or by the transfer of energy by phase changes."

543. Seo discloses the actuator consists of, or comprises, a thermoelectric actuator and is a heater or a cooler, operative for affecting the temperature of a solid, a liquid, or a gas object, and is coupled to the object by conduction, convection, force convention, thermal radiation, or by the transfer of energy by phase changes.

544. Seo's "*refrigerator*" is operated by the driving of a *compressor* equipped *inside the refrigerator* [e.g., the *single enclosure*]." (EX1005, [0003].) The compressor "allow[s] the food inside the refrigerator to be stored at the desired temperature [e.g., affecting the physical phenomenon (temperature)]." (EX1005, [0003]; *see also* EX1001, 41:23-32, 97:18-26.)

545. Seo's *compressor* is a *thermoelectric cooling actuator* that is coupled to an object by *convection* or by the transfer of energy by phase changes. "The cold air [is]. . . supplied to the inside of the refrigerator by repeatedly performing the *compression-condensation-expansion-evaporation* cycle, and the refrigerant supplied . . . is evenly distributed inside the refrigerator by *convection*." (EX1005, [0003].) As described by the '590 patent, a compressor is a thermoelectric cooling actuator. (EX1001, 41:23-32, 97:18-26.)

L. Ground 12: Seo in view of Chan and Goldsmith Render Claims 20-22

1. Motivation to Combine

546. Seo, Chan, and Goldsmith are analogous art to the '590 patent. All relate to wireless communication techniques for connecting electronic devices/components over different types of wireless networks. Seo's "communication unit 440 is connected to the external power device by wired or wireless communication, and may be connected in particular through serial communication, the Internet, power line communication, wireless LAN, or the like." (EX1005, [0049], [0051].) Chan discloses its appliance module may communicate using "a wireless RF signal" or "***other wireless technologies, WiFi, ZigBee, Bluetooth, WPAN, RFID, UWB, infrared (IR), or other media.***" (EX1004, [0070], [0073], Claim 2.) Seo and Chan expressly recognize that multiple wireless standards are used for wireless communications. Goldsmith provides a comprehensive overview of the various wireless systems and networking techniques available at 2005, including broadband wireless network, satellite network, WiMax, GSM, and 3G cellular systems in a chapter titled "1.4 Current Wireless Systems." (EX1009, 8-21.) Thus, all references are from the same field of endeavor and are reasonably pertinent to the same technical problem of providing reliable and flexible wireless communication between devices/appliances and networks.

547. It would have been obvious for a POSITA to look to Goldsmith for conventional wireless networking techniques and protocols that can be applied to

Seo's system, which expressly recognized communication via multiple wireless technologies. (EX1005, [0049], [0051], Claim 2.) Goldsmith explains the underlying principles, frequency bands, modulation techniques, and considerations of adopting wireless systems such as WLAN (IEEE 802.11), WiMax (IEEE 802.16, Bluetooth), broadband wireless network, satellite network, and cellular systems (3G, GSM), and therefore provides implementation details and/or design options to a POSITA for implementing Seo. A POSITA would have recognized that Seo's communication unit could be implemented using any of these standard wireless protocols disclosed by Goldsmith, such as WiFi (WLAN), WiMAX, satellite networks, or cellular (3G/GSM), depending on desired range, data rate, or coverage area.

548. Further, it would have been obvious to try combining the teachings of Seo and Goldsmith, as there were a finite number of identified and predictable wireless networking technologies, such as Bluetooth, WPAN, WLAN, WiFi, WiMax, satellite, GSM, 3G, some of which are expressly disclosed in Seo, that were well-known and commercially established at that time. A POSITA would have had a reasonable expectation of success in applying Goldsmith's teachings of known wireless protocols to Seo's communication unit for communication, since communication via these wireless protocols were routine and well-known in the field. The known benefits and feasibility of employing such standardized wireless

technologies, as taught by Goldsmith, would have prompted their application in Seo's system based on common design incentives and market trends.

549. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by widespread and successful implementations of standardized wireless protocols in consumer and industrial communication devices during the relevant time period. Prior art such as Goldsmith and Chan has successfully demonstrated that standardized systems (*e.g.*, IEEE 802.11 (WiFi), IEEE 802.16 (WiMAX), GSM, and 3G cellular) can be reliably integrated to enable robust, interoperable, and scalable wireless communication across diverse device platforms. A POSITA would have had a reasonable expectation of success integrating these standardized systems, motivated by known benefits such as improved compatibility, scalability, and performance. Thus, there would have been a reasonable expectation of success for combining Seo, Chan, and Goldsmith to achieve reliable wireless connectivity.

2. Claim 20: The appliance according to claim 1, wherein the wireless network is a Wireless Personal Area Network (WPAN), the antenna is a WPAN antenna, and the wireless transceiver is a WPAN modem.

550. Seo-Chan-Goldsmith discloses the wireless network is a Wireless Personal Area Network (WPAN), the antenna is a WPAN antenna, and the wireless transceiver is a WPAN modem. Seo's "communication unit 440 is

connected to the external power device by . . . *wireless communication*, and may be connected in particular through . . . the Internet, . . . wireless LAN, or *the like*.” (EX1005, [0051], [0083], Claim 2; *Supra*, IV.K.3.g.)

551. Goldsmith discloses that the wireless systems available in 2005 include **WPAN**. (EX1009, 19, 601-602.) “As radios decrease their cost and power consumption, it becomes feasible to embed them into more types of electronic devices, which can be used to create *smart homes*, *sensor networks*, and other compelling applications. Two radios have emerged to support this trend: **Bluetooth** and **ZigBee**.” (EX1009, 19.) “ZigBee, Bluetooth, and UWB (ultrawideband), . . . have emerged to support a wide range of short-distance wireless network applications. These specifications are designed to be compliant with the IEEE 802.15 standards, a family of IEEE standards for short-distance wireless networking called Wireless Personal Area Networks (WPANs).” (EX1009, 601-602.)

552. It would have been obvious to a POSITA that “WPAN,” a form of popular wireless communication system available in 2005, would be implemented in Seo. Integrating satellite communication functionality into the communication unit would enable short-range, low-power, and cost-effective wireless communication between the refrigerator and external devices. WPAN technologies such as Bluetooth and ZigBee were well-established, commercially

available, and compatible with standard networking protocols. (EX1009, 19-20.)

Seo already discloses wireless communication capabilities and emphasizes

reducing and managing power consumption. (EX[[SEO]], [0001], [0051].)

WPAN technologies such as Bluetooth and ZigBee were expressly designed for

low-power operation, making them particularly suitable for energy-efficient

appliances. (EX[[GOLDSMITH]], 19-20.) Moreover, incorporating WPAN

connectivity would reduce wiring, simplify installation, and improve

interoperability with other home appliances and smart devices, consistent with the

trend toward networked home systems described by Goldsmith. Thus, a POSITA

would have found it obvious to use “WPAN,” a form of popular wireless

communication system available in 2005 when implementing Seo.

553. Seo-Chan-Goldsmith also discloses the antenna is a WPAN antenna, and the wireless transceiver is a WPAN modem. “The Bluetooth standard is based on a tiny microchip incorporating a radio transceiver that is built into digital

devices.” (EX1009, 19.) It was well-known that wireless communication utilizes

“a *transmitter* (*transmitter electronics* plus *antenna*) generating (electromagnetic) signals” and “a *receiver* (*receiving electronics* plus *antenna*.” (EX1018, 369.)

Thus, a POSITA would have understood (and found it obvious) that

communication via WPAN would utilize a WPAN antenna and a WPAN modem

(acting as a WPAN transceiver).

3. Claim 21: The appliance according to claim 20, wherein the WPAN is according to, based on, or compatible with, Bluetooth™ or Institute of Electrical and Electronics Engineers (IEEE) 802.15.1-2005 standards.

554. Seo-Chan-Goldsmith discloses the WPAN is according to, based on, or compatible with, Bluetooth or IEEE 802.15.1-2005 standards. As discussed above, a POSITA would have been motivated to utilize WPAN when implementing Seo's communication unit. (*Supra* §IX.L.2.)

555. As discussed by Goldsmith, WPAN includes Bluetooth and ZigBee, which "can be used to create *smart homes, sensor networks*, and other compelling applications." (EX1009, 19.) Further, by 2005, Bluetooth had "been adopted by over 1,300 manufacturers, and many consumer electronic products incorporate Bluetooth. These include wireless headsets for cell phones, wireless USB or RS232 connectors, wireless PCMCIA cards, and wireless settop boxes." (EX1009, 20.) "Portions of the Bluetooth standard were formally adopted by the IEEE as its *802.15.1* standard." (EX1009, 602.)

556. It would have been obvious to try utilizing Bluetooth when implementing WPAN connectivity. Bluetooth was a mature, standardized, and widely adopted short-range communication protocol expressly designed for low-power wireless data exchange between electronic devices. (EX1009, 19-20.) A POSITA would have recognized that these well-known WPAN standards

(Bluetooth, Zigbee, and UWB) represented a finite number of predictable options for implementing short-range, low-power wireless communication. Selecting Bluetooth would have been an obvious choice because it was commercially available, compatible with consumer electronics, and provided reliable, low-power connectivity consistent with Seo's energy-management objectives.

4. Claim 22: The appliance according to claim 20, wherein the WPAN is according to, based on, or compatible with, Zigbee™, IEEE 802.15.4-2003, or Z-Wave™ standards.

557. Seo-Chan-Goldsmith discloses the WPAN is according to, based on, or compatible with, Zigbee or IEEE 802.15.4-2003 standards. As discussed above, a POSITA would have been motivated to utilize WPAN when implementing Seo's communication unit. (*Supra* §IX.L.2.)

558. As discussed by Goldsmith, WPAN includes Bluetooth and ZigBee, which "can be used to create *smart homes, sensor networks*, and other compelling applications." (EX1009, 19.) "The ZigBee 5 radio specification is designed for lower cost and power consumption than Bluetooth [19]. Its specification is based on the IEEE 802.15.4 standard. The radio operates in the same ISM band as Bluetooth and is capable of connecting 255 devices per network. The specification supports data rates of up to 250 kbps at a range of up to 30 m. These data rates are slower than Bluetooth, but in exchange the radio consumes significantly less power with a larger transmission range. The goal of Zig Bee is to provide radio operation

for months or years without recharging, thereby targeting applications such as sensor networks and inventory tags” (EX1009, 20.)

559. It would have been obvious to try utilizing ZigBee when implementing WPAN connectivity. ZigBee was a mature, standardized, and widely adopted short-range communication protocol expressly designed for low-power wireless data exchange between electronic devices. (EX1009, 19-20.) A POSITA would have recognized that these well-known WPAN standards (Bluetooth, Zigbee, and UWB) represented a finite number of predictable options for implementing short-range, low-power wireless communication. Selecting ZigBee would have been an obvious choice because it was commercially available, compatible with consumer electronics, and provided reliable, low-power connectivity consistent with Seo’s energy-management objectives.

M. Ground 13: Seo in view of Chan and Fraden Render Claims 35 and 39 Obvious

1. Motivation to Combine:

560. A POSITA would have been motivated to combine the teachings of Seo, Chan, and Fraden because all three references address sensor systems used to detect and monitor environmental or operational conditions in appliances. Seo, Chan, and Fraden are analogous to the field of the ’590 patent. All relate to the use of sensors for detecting and monitoring physical, environmental, and electrical parameters in appliance and control systems. (EX1005, [0012], [0020]-[0022],

[0027]-[0031], [0047], [0055], [0057]-[0061], [0071]; EX1004, [0070], [0109], Claims 3-16; EX1012, chapters 6, 10-11, 13-17.) Seo discloses sensors that detect temperature, humidity, and operational parameters of a refrigerator and transmit that information for control and energy management. (EX1005, [0020]-[0022], [0047], [0055].) Chan likewise teaches appliance modules incorporating various types of sensors—such as temperature, humidity, motion, infrared, pressure, smoke, and biological sensors—for monitoring appliance status and environmental conditions. (EX1004, [0070], [0109].) Fraden provides a comprehensive treatment of sensor technologies, describing the design, principles, and implementation of sensors such as thermistors, thermocouples, photoelectric and radiation sensors, humidity sensors, accelerometers, gas and chemical sensors, and optical detectors. (EX1012, Chapters 6, 10-11, 13-17.)

561. A POSITA would have been motivated to look to Fraden to implement Seo's sensors. Applying Fraden's sensor types and design considerations would improve the accuracy, sensitivity, and reliability of Seo's detection units while simplifying implementation through standardized, well-understood components. Moreover, Chan confirms the routine use and interchangeability of such sensor technologies in appliance systems, demonstrating that integrating Fraden's sensor architectures into Seo's refrigerator would have been straightforward and predictable.

562. The combination would have been straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by successful implementations in the field. Fraden's sensor technologies were mature, standardized, and widely used in consumer and industrial electronics for environmental and operational monitoring. Prior art such as Fraden has successfully demonstrated that standardized sensor technologies (*e.g.*, thermistors, thermocouples, photoelectric detectors, humidity sensors, accelerometers, and gas sensors) can be reliably integrated across monitoring systems to measure temperature, pressure, motion, light, and chemical composition. These sensor architectures were commercially available and routinely applied in comparable control and monitoring devices. Thus, there would have been a reasonable expectation of success for combining Seo, Chan, and Fraden to achieve predictable improvements in sensor accuracy, reliability, and functionality in Seo's appliance control system.

2. Claim 35: "The appliance according to claim 1, wherein the first sensor is a thermoelectric sensor that responds to a temperature or to a temperature gradient of an object using a conduction, convection, or radiation, and wherein the thermoelectric sensor consists of, or comprises, a Positive Temperature Coefficient (PTC) thermistor, a Negative Temperature Coefficient (NTC) thermistor, a thermocouple, a quartz crystal, or a Resistance Temperature Detector (RTD)."

563. Seo-Chan-Fraden discloses the *first sensor* is a thermoelectric sensor that responds to a temperature or to a temperature gradient of an object using a

conduction, convection, or radiation, and wherein the thermoelectric sensor consists of, or comprises, a Positive Temperature Coefficient (PTC) thermistor, a Negative Temperature Coefficient (NTC) thermistor, a thermocouple, a quartz crystal, or a Resistance Temperature Detector (RTD). As discussed above, Seo's "state detection unit 430 may include one or more internal temperature detection units 431 that detect the temperature within one or more storage compartments provided inside the refrigerator" and "an external temperature detection unit 433 that detects the temperature outside the refrigerator, that is, the room temperature." (EX1005, [0027]-[0028].)

564. Seo-Chan-Fraden discloses temperature sensor is a thermoelectric sensor that responds to a temperature or to a temperature gradient of an object using conduction, convection, or radiation. "Taking a temperature essentially requires the transmission of a small portion of the object's thermal energy to the sensor whose function is to convert that energy into an electrical signal. When a contact sensor (probe) is placed inside or on the object, *heat conduction* takes place through the boundary between the object and the probe. The sensing element in the probe warms up or cools down, *i.e.*, it exchanges heat with the object. The same happens when heat is transferred by means of radiation - thermal energy in the form of infrared light is exchanged between the sensor and the object. Any sensor, no matter how small, will disturb the measurement site and thus cause

some error in temperature measurement. This applies to any method of sensing: ***conductive, convective, and radiative.***” (EX1012, 519.)

565. Seo-Chan-Fraden discloses the thermoelectric sensor consists of, or comprises, a Positive Temperature Coefficient (PTC) thermistor, a Negative Temperature Coefficient (NTC) thermistor, a thermocouple, or a Resistance Temperature Detector (RTD). Fraden discloses that ***thermistors, resistance temperature detectors (RTDs), and thermocouple*** are common temperature sensors. (EX1012, 526; EX1020, 34.) For example, Fraden discloses that “[a]ll temperature sensors can be divided into two classes: the absolute sensors and the relative sensors. An absolute temperature sensor ***measures temperature*** that is referenced to the absolute zero or any other point on the absolute temperature scale, for example 0°C (273.15K), 25°C or a selected calibration temperature. Examples of the absolute sensors are ***thermistors*** and ***resistance temperature detectors (RTDs)***. A relative sensor ***measures a temperature difference*** between two objects where one object is called the reference. An example of a relative sensor is a ***thermocouple.***” (EX1012, 526; *see also*, EX1020, 34.) A POSITA would have understood (and found it obvious) that any of Seo’s temperature detection units is a Positive Temperature Coefficient (PTC) thermistor, a Negative Temperature Coefficient (NTC) thermistor, a thermocouple, or a Resistance Temperature Detector (RTD).

3. Claim 39: “The appliance according to claim 1, wherein the first sensor consists of, or comprises, a bulk or surface acoustic sensor.”

566. Seo-Chan-Fraden discloses the first sensor comprises a surface acoustic sensor. As discussed above, Seo discloses numerous *first sensors* in the control device 400, including “*internal temperature detection units* (431),” “an *external temperature detection unit 433*,” “a *gas sensor* (not shown),” “a *voltage detection unit*,” and “a *sensor* (not shown) that *detects the opening and closing of the door*.” (EX1005, [0057]-[0061], [0012], [0020]-[0022], [0027]-[0031], [0047], [0055], [0071].)

567. Fraden discloses that temperature sensors may be acoustic sensors. “A miniature *temperature sensor* can be fabricated with the *surface acoustic waves* (SAW) and plate waves (PW) techniques (see Section 12.7). The idea behind such a sensor is in the temperature modulation of some mechanical parameters of a time-keeping element in the electronic oscillator [24, 25]. This leads to a change in the oscillating frequency. In effect, such an integral acoustic sensor becomes a direct converter of temperature into frequency.” (EX1012, 564-565.)

568. It would have been obvious to a POSITA to implement Seo’s *temperature sensors* with surface acoustic sensors.

N. Ground 14: Seo in view of Chan and Betts-LaCroix Render Claim 58 Obvious

1. Summary of Betts-LaCroix

569. Betts-LaCroix is a patent describing improvements to OLED technology. (EX1050, Abstract, [0003].) “An organic light-emitting diode (OLED) is a light-emitting diode having an emissive electroluminescent layer containing organic compounds. (EX1050, [0002].)

570. Betts-LaCroix was published in 2010 and is prior art under 35 U.S.C. §§102(b). (EX1037.) The Examiner never found, and Applicant never cited, Betts-LaCroix during prosecution. Betts-LaCroix and the ’590 patent are analogous art. Both relate to visual display systems. The ’590 patent describes that an OLED is an electrochemical actuator operative for changing or affecting matter structure or properties by emitting visible light in response to an electrical signal. (EX1001, 25:33-37; 111:42-61; 95:45-52, 39:10-26.) Betts-LaCroix likewise discloses OLED technologies used to form high-efficiency, low-power displays for electronic devices. (EX1050, [0002].)

2. Motivation to Combine

571. A POSITA would have been motivated to combine the teachings of Seo, Chan, and Betts-LaCroix because all references concern electronic systems incorporating display functionality. Seo discloses a refrigerator having a “screen display unit” that provides visual information to the user. (EX1005, [0041],

[0074].) Betts-LaCroix discloses OLED technology “used in display systems such as computer displays, personal digital assistant (PDA) screens, television screens, etc.” (EX1050, [0002].)

572. A POSITA would have recognized that substituting Seo’s display unit with an OLED display as taught by Betts-LaCroix would have been a straightforward design improvement. OLED displays were well-known for providing lower energy consumption than LCD panels, consistent with the energy-efficiency goals of Seo’s and Chan’s systems. (EX1050, [0002].) Integrating an OLED display driven by TFT circuitry into Seo’s refrigerator would reduce power consumption, improve display readability, and allow for a thinner, more reliable interface without requiring any inventive modification of the appliance’s existing electronic control architecture.

573. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by successful implementations of OLED displays in the prior art. (EX1050, [0002]; EX1015, 174.) Thus, there would have been a reasonable expectation of success for combining Seo, Chan, and Betts-LaCroix to implement Seo’s screen display unit using an OLED electrochemical actuator, achieving predictable and beneficial improvements in power efficiency and display performance.

3. Claim 58: “The appliance according to claim 53, wherein the actuator consists of, or comprises, a chemical or an electrochemical actuator, and is operative for producing, changing, or affecting a matter structure, properties, composition, process, or reactions.”

574. Seo-Chan-Betts-LaCroix discloses the actuator comprises an *electrochemical* actuator operative for changing or affecting matter structure or properties. Seo’s refrigerator has a “*screen display unit.*” (EX1005, [0041], [0074].)

575. Betts-LaCroix discloses “An organic light-emitting diode (OLED) is a light-emitting diode having an emissive electroluminescent layer containing organic compounds. In an OLED display, OLEDs function as picture elements or pixels arranged in a two-dimensional grid or array, where each pixel represents a portion a displayed image. OLED technology is *used in display systems* such as computer displays, personal digital assistant (PDA) screens, television screens, etc. Unlike liquid crystal displays (LCDs), OLED displays do not require a backlight to function and *thus consume far less power than LCDs.* (EX1050, [0002].)

576. Additionally, Kuo, a compendium of symposium papers related to thin film transistor systems, discloses that “Liquid Crystal Displays have now been in the market for a number of years; however recent enhancements on Organic Light Emitting Devices (OLED’s) offer a new alternative to the Flat Panel Display industry. OLED’s offer improved luminous efficiency, high brightness, and

excellent viewing angle. In addition, OLED displays have thinner profiles, weight less, and consume less power than LCD's." (EX1015, 174.)

577. A POSITA would have found it obvious to use an OLED screen in Seo's refrigerator to reduce power usage. A POSITA would have known that OLED is an electrochemical actuator operative for changing or affecting matter structure or properties. For example, it was well-known that "[t]heir structure consist of a series of thin films that usually include electron and hole injection layers, electron and hole transport layers, and an emissive layer... When the holes and electrons recombine in the emissive layer light is produced." (EX1015, 174.) This is consistent with the '590 patent. (EX1001, 25:33-37 ("An actuator may be a display for presentation of visual data or information, commonly on a screen, and may consist of an array (*e.g.*, matrix) of light emitters or light reflectors, and may present text, graphics, image or video."); 111:42-61 ("A display may be an Organic Light-Emitting Diode (OLED) display, a display device that sandwiches carbon-based films between two charged electrodes, one a metallic cathode and one a transparent anode, usually being glass. The organic films consist of a hole-injection layer, a hole-transport layer, an emissive layer and an electron-transport layer. When voltage is applied to the OLED cell, the injected positive and negative charges recombine in the emissive layer and create electro luminescent light. Unlike LCDs, which require backlighting, OLED displays are emissive devices-

they emit light rather than modulate transmitted or reflected light. There are two main families of OLEDs: those based on small molecules and those employing polymers. Adding mobile ions to an OLED *creates a light-emitting electrochemical cell* or LEC, which has a slightly different mode of operation.”), 95:45-52 (“In an Organic Light-Emitting Diodes (OLEDs) the electroluminescent material comprising the emissive layer of the diode, is an organic compound. The organic material is electrically conductive due to the delocalization of pi electrons caused by conjugation over all or part of the molecule, and the material therefore functions as an organic semiconductor. The organic materials can be small organic molecules in a crystalline phase, or polymers”), 39:10-26.)

578. Thus, POSITA would have found it obvious to use an OLED screen, which is an electrochemical actuator, when implementing Seo’s display screen unit.

O. Ground 15: Seo in view of Chan and Doherty Render Obvious Claims 60-63

1. Motivation to Combine

579. It would have been obvious for a POSITA to apply Doherty’s teachings on addressable wireless home networking to Seo’s refrigerator. Seo, Chan, and Doherty are directed to the field of wireless communication among in-home devices, including connection to a home network for data exchange and remote control. Seo’s “communication unit 440 is connected to the external power

device by wired or wireless communication, and may be connected in particular through serial communication, the Internet, power line communication, wireless LAN, or the like.” (EX1005, [0049], [0051].) Chan discloses that its appliance module communicates wirelessly with a gateway over various wireless technologies such as “WiFi, *ZigBee*, *Bluetooth*, *WPAN*, RFID, *UWB*, infrared (IR), or other media.” (EX1004, [0070], [0073].) Doherty provides detailed explanation of how conventional wireless home networks operate, including the idea of addressing each networked device to the wireless network. (EX1013, 99, 100, 166, 108, 210, 175.) Thus, all references are from the same field of endeavor and are reasonably pertinent to the same technical problem of enabling wireless communication and device identification within a home network.

580. A POSITA would have been motivated to combine the teachings of Seo and Doherty so that the wireless communication unit in Seo’s refrigerator system could be uniquely addressable within the home wireless network or over the Internet. Doherty explicitly teaches that each device participating in the home wireless network must have a distinct, locally or universally administered digital address, such as a MAC address or an assigned IP address for routing communications. Incorporating Doherty’s addressing scheme into Seo’s system would have been a straightforward and predictable combination, allowing the refrigerator to be uniquely identified by other devices on the network. This would

facilitate and enable direct control and data exchange with the refrigerator. At the time of the invention, there was a finite number of well-established methods for uniquely identifying networked devices, such as assigning locally administered MAC address or universally administered address, and a POSITA would have found it obvious to apply these to Seo's communication unit. The known benefits of addressing appliances in the wireless network using distinct addresses as taught by Doherty would prompt the application of Doherty in the same field based on design incentives and other market forces.

581. The combination is straightforward and readily achievable by a person of ordinary skill in the art, as demonstrated by widespread and successful implementations of standardized addressing schemes in consumer and home networking systems. Prior art such as Doherty has successfully demonstrated that the use of unique MAC and IP addresses enables reliable device identification, network routing, and management in wireless local area networks (WLANs) and Internet-connected home systems. Thus, there would have been a reasonable expectation of success for combining Seo and Doherty to achieve predictable and reliable addressable communication.

2. Claim 60: The appliance according to claim 1, further being addressable in the wireless network using distinct locally administered addresses or universally administered digital addresses stored in a volatile or non-volatile memory in the single enclosure, which uniquely identifying the appliance in the wireless network or in the Internet.

582. Seo-Chan-Doherty discloses the appliance module is addressable in the wireless network using distinct locally administered addresses or universally administered digital addresses, such as a universally administered MAC address assigned to the device's wireless network interface card (NIC) at the time of the manufacture, or a locally administered address later assigned.

583. As discussed, Seo's "communication unit 440 is connected to the external power device by wired or wireless communication, and may be connected in particular through serial communication, the Internet, power line communication, wireless LAN, or the like." (EX1005, [0049], [0051].) Doherty discloses that "[e]ach computer or device that you want to join your wireless network needs a wireless network interface card (NIC)" and "*each wireless card has a unique identifier called a MAC address.*" (EX1013, 99, 166.) This unique identifier is assigned to the NIC at its manufacture and is thus a universally administered address (locally stored in the non-volatile memory). "[A] *MAC address . . . is a 48-bit binary number generally written as 12 hexadecimal digits (six groups of two digits, the groups separated by dashes or colons). The address is set at the time of the NIC's manufacture . . .* The second least significant bit of the most significant byte MAC address is known as the *universal or locally administered address (U/L) bit* . If this bit is set to 0, the address is administered universally. This means that the address was assigned by the Institute of Electrical

and Electronics Engineers (IEEE) and is unique across the globe. If the bit is set to 1, it indicates that the address was selected locally by a network administrator (overriding the NIC's BIA)." (EX1027, 24.)

584. A POSITA would have understood (and found it obvious) that these addresses uniquely identify the refrigerator in the wireless network or in the Internet. For example, as discussed, if the MAC address is administered universally, the address is "*unique across the globe.*"

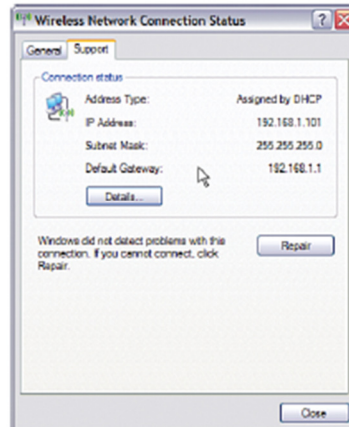
585. Further, "each device (computer, laptop, and so on) *in a home network* needs to have an *IP address*, which is how the device is known on the network . . . Most home networks use IP addresses in the range of 192.168.1.100 to 192.168.1.149, and the *router assigns each device an address* from this pool when it boots." (EX1013, 108, 210, 175.) "Internet protocol (IP) addresses are the *unique numbers used to identify individual connections* to the Internet."

(EX1025, 127.) A POSITA would have understood (and found it obvious) that the IP address may be an assigned IP address for the device (*e.g.*, by the router), the router's IP address, a combination of the two, or a globally unique IP address. A POSITA would have understood that these are stored on local memories.

586. As shown in the figure below, Doherty discloses that networked devices display the IP address assigned, which means the IP address is locally stored in the device. (EX1013, 211, Figure 10-44, 265.) Thus, a POSITA would

have understood (and found it obvious) that the Seo's refrigerator locally stores the IP address in a volatile or non-volatile memory.

Figure 10-44 Verifying IP Address Assignment with Windows XP



3. Claim 61: The appliance according to claim 60, wherein the digital address is a Media Access Control (MAC) layer address that is MAC-48, Extended Unique Identifier (EUI) EUI-48, or EUI-64 address type.

587. Seo-Chan-Doherty discloses the digital address is a Media Access Control (MAC) layer address that is MAC-48, Extended Unique Identifier (EUI) EUI-48, or EUI-64 address type. As discussed, Seo-Chan-Doherty discloses its appliance is addressable in the wireless network using a Media Access Control (MAC) layer address. (*Supra*, §IX.O.2.)

588. At the time of the invention, it was well-known that networked devices are associated with MAC addresses of the MAC-48, EUI-48, or EUI-64 type. For example, Doherty discloses that “[*e*]ach computer or device that you

want to join your wireless network needs a wireless network interface card (NIC)” and “each wireless card has a unique identifier called a MAC address.” (EX1013, 99, 166.) A POSITA would have known (and found it obvious that) “[m]ost MAC addresses use one of the IEEE standardized protocols; **MAC-48**, **EUI-48®**, and **EUI-64®**.” (EX1048, 2:50-59.)

4. Claim 62: The appliance according to claim 60, wherein the digital address is a layer 3 address and is static or dynamic Internet Protocol (IP) address that is IPv4 or IPv6 type address.

589. As discussed, Seo-Chan-Doherty discloses its appliance is addressable in the wireless network using an Internet Protocol (IP) address. (*Supra*, §IX.O.2.)

590. Further, as discussed, Seo-Chan-Doherty discloses its refrigerator communicates with a wireless network. (*Supra*, §IX.K.3.c.)

591. A POSITA would have understood (and found it obvious) that this involves assigning the refrigerator with a device identifier or address such as an IP address. For example, Doherty discloses that “*each device (computer, laptop, and so on) in a home network needs to have an IP address*, which is how the device is known on the network . . . Most home networks use IP addresses in the range of 192.168.1.100 to 192.168.1.149, and the *router assigns each device an address* from this pool when it boots.” (EX1013, 108, 210, 175.)

592. At the time of the invention, it was well-known that Internet Protocol (IP) addresses are layer 3 addresses, either static or dynamic, and are IPv4

addresses. “In the case of today’s Internet, these addresses are Internet protocol version 4 (IPv4) addresses.” (EX1025, 127.) “Internet protocol (IP) addresses are the unique numbers used to identify individual connections to the Internet.” *Id.* “Internet Protocol (IP) is a Layer 3 protocol that contains addressing and control information that allows packets to be routed.” (EX1027, 11.) “The IP system in common use today is known as IPv4, for Internet Protocol version 4. A newer system, IPv6, or Internet Protocol version 6, has been developed and exists today in small deployments.” (EX1027, 13.)

593. Further, Doherty discloses that IP addresses are either static or dynamic. “The broadband networks typically assign a *dynamic IP address* to your broadband service. Dynamic means the IP address can change[.]” (EX1013, 277.) Further, an IP address may be a “*static IP address*, which means . . . your address never changes.” *Id.*

5. Claim 63: The appliance according to claim 60, wherein the digital address is autonomously assigned, or wherein the digital address is assigned by another appliance using Dynamic Host Configuration Protocol (DHCP).

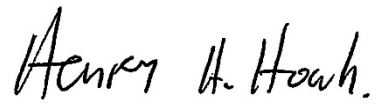
594. Seo-Chan-Doherty discloses the digital address is assigned by another appliance using Dynamic Host Configuration Protocol (DHCP). As discussed, Chan discloses that digital addresses such as IP address is assigned to the appliance. (*Supra*, §IX.O.2.)

595. As discussed, such IP addresses may be dynamic IP addresses. (*Supra*, §IX.O.4.) A POSITA would have understood (and found it obvious) that dynamic IP addresses are autonomously assigned and are assigned by another appliance using Dynamic Host Configuration Protocol (DHCP). For example, Doherty discloses that “[m]ost home networks use IP addresses in the range of 192.168.1.100 to 192.168.1.149, and **the router assigns** each device an address from this pool when it boots. This is called dynamic IP addressing, or ***Dynamic Host Configuration Protocol (DHCP)*** . . . With dynamic IP addressing, or DHCP, enabled on the wireless router, when a NIC establishes a new wireless connection, it then requests an address from the router, and the router assigns the next available one from the pool.” (EX1013, 210.) “[***D***ynamic host configuration protocol (DHCP), [] allows end-user hosts to be configured ***automatically with an address*** for the duration of their use. When a DHCP client starts up it searches for a DHCP server and obtains set-up information, including an IP address[.]” (EX1025, 135.)

* * *

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

Dated: November 21, 2025


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Education

Massachusetts Institute of Technology, Cambridge, MA

- PhD in Electrical Engineering and Computer Science, February 1998. “Designing Networks for Tomorrow's Traffic,” thesis supervised by Professor David Tennenhouse and Professor John Guttag. GPA 4.7/5.0
- Master of Science in Electrical Engineering and Computer Science, February 1991. “Demonstration of a laser repetition rate multiplier,” thesis. GPA 4.5/5.0
- Bachelor of Science in Electrical Engineering and Computer Science, June 1989. “Boundary element analysis of arbitrarily shaped dielectric structures,” thesis. GPA 4.7/5.0
- Bachelor of Science in Physics, February 1990. GPA 4.7/5.0

MITx, Cambridge, MA

- 2020 – 2021: Completed four courses in the Statistics and Data Science MicroMasters program, a sequence of MIT-offered graduate-level courses in statistics and machine learning.

Experience

Houh Consulting Inc. / Independent Consultant

- 2009 - present: Technical consultant specializing in Social Networking, Web 2.0, Web Site Development, Data Networking, Optical Networking, Telecommunications, Media Streaming and Voice Over IP. Clients include: Akin Gump Strauss Hauer & Feld LLP, Arnold & Porter Kaye Scholer LLP, BBN, Baker Botts LLP, Barnes & Thornburg LLP, BBN Technologies, Beus Gilbert McGroder PLLC, Bracewell LLP, Christensen O'Connor Johnson Kindness PLLC, Cooley LLP, Covington & Burling LLP, Cozen O'Connor P.C., DLA Piper, Davis Polk & Wardwell LLP, Desmarais LLP, Duane Morris LLP, Erise IP, P.A., Faegre Baker Daniels LLP, Finnegan, Henderson, Farabow, Garrett & Dunner, LLP, Fish & Richardson P.C., Goldman Ismail Tomaselli Brennan & Baum LLP, Haynes and Boone, LLP, Kaye Scholer, Kellogg Huber Hanson Todd Evans & Figel PLLC, Kirkland & Ellis LLP, Klarquist Sparkman, LLP, McCarthy Tetrault LLP, McGuireWoods LLP, Morgan, Lewis & Bockius LLP, Munger Tolles & Olson LLP, Orrick, Herrington & Sutcliffe LLP, O'Melveny & Myers LLP, Orrick, Herrington & Sutcliffe LLP, Paul Hastings LLP, Paul, Weiss, Rifkind, Wharton & Garrison LLP, Perkins Coie LLP, Quinn Emanuel Urquhart & Sullivan, LLP, Sidley Austin LLP, Smith Baluch LLP, Sterne, Kessler, Goldstein & Fox PLLC, Troutman Sanders LLP, Venable LLP, Weil, Gotshal & Manges LLP, Wiley Rein LLP, Wilmer Cutler Pickering Hale and Dorr LLP, and Winston & Strawn LLP.

BlocksCAD Inc. (H3XL spin-out)

- 2014 – 2025: Founder and member of Board of Directors. BlocksCAD is a visual Computer-Aided Design (CAD) program, designed to teach children mathematics and geometric visualization. BlocksCAD is being used in U.S. schools and worldwide in maker spaces, with 350,000+ users. BlocksCAD was selected to be part of the LearnLaunch 2017 Boost Accelerator, the MIT Play Labs 2018 Summer Accelerator, and the MassChallenge 2018 Boston Cohort. Recipient of DARPA DSO grant in 2014, and SBIR grant from the USDA in 2019. BlocksCAD was acquired by zSpace in 2025.

H3XL Inc. d/b/a Einstein's Workshop (formerly Lexington Robotics)

- 2009 - 2022: Founder and President. Started a science, technology, engineering and math enrichment program and creative/maker space, in 7,000 square feet of space. Serve 2,000+ kids and families annually. As of end of 2022, have delivered an estimated 250,000 student-instruction-hours of STEM courses. Principle Investigator for 2-year DARPA grant to improve 3D Computer Aided Design tool developed in-house for the purposes of teaching 8 year olds and up 3D CAD.

Eons

- 2008 - 2009: Chief Technology Officer. Created product that Eons acquired from BBN Technologies. Integrated BBN product with Eons social networking platform and significantly increased the Eons group creation rate. Helped evaluate advertisement platform offerings and rolled out the “Boom Network” advertising network. Eons raised \$32 million from General Catalyst Partners, Charles River Ventures, Sequoia Capital, and Intel Capital.

BBN Technologies

- 2007 - 2008: Delta Division, Vice President of Technology. Grew “Boomerang” counter-sniper project engineering team and significantly de-risked \$10 million worth of product deliveries. Identified sales team leading to \$10 million dollars of new sales within 6 months and \$100+ million in additional orders in the following two years. Boomerang was a significant asset leading to the acquisition of BBN by Raytheon in 2009. Created new business plan and grew team; launched new fully-featured social networking web site in 5 months. Served as lead expert witness in patent infringement lawsuit, resulting in \$58 million jury award to client; verdict for patents I testified on were upheld on appeal which resulted in a \$120 million settlement.
- 2004 - 2007: Delta Division, Director of Technology, responsible for commercializing IP and creating new businesses. Hired and grew division's initial engineering team. Wrote three business plans, two of which were funded. For call center business plan, acted as general manager, hiring and managing engineering team, inside sales team, and identifying and recruiting a new general manager. Identified and recruited other key employees to Delta Division, including senior members of team leading to successful internal sales growth and spin-outs of projects. Contracted by BBN to BBN spin-out PodZinger as VP of Operations and Technology. Additional areas studied include mesh networking, network security, satellite communications, and semantic web.

PodZinger Inc. (BBN spin-out, also known as EveryZing and now RAMP)

- 2006: Vice President of Operations and Technology. Significantly upgraded capability of consumer-facing search site and redeployed web site from company to co-location facility. Identified key portions of infrastructure for upgrading and cost reduction. Helped write business plan, evaluating advertisement models of revenue. Hired in operations replacement and phased back to BBN.

Commonwealth Capital

- 2004: Entrepreneur-in-residence (informally), performed technical due diligence on business plans, brainstormed ideas for new businesses with venture partner. With venture partner, left for portfolio company BBN to form core of commercialization team.

Empirix, Inc./Teradyne, Inc.

- 2001 - 2004: Chief Technologist, Engineering Manager, Web Application Test Group. Researched potential new product areas; developed product plan and prototype. Responsible for three new and existing products. Managed off-shore development team. Chief architect for all web testing products. Re-architected core testing product, helped write javascript interpreter. Provided technical vision for core product.
- 2000 - 2001: Chief Technologist, Communication Infrastructure Test Group. Responsible for incorporating new technology internally, tracking new technologies, technical evaluation of partnerships and potential acquisitions. Helped develop division strategy. Developed plans which formed core capabilities for successful new products introduced in 2004-5.
- 2000 - 2001: Engineering Manager, Communications Infrastructure Test Group. Execution of new product plan developed in prior role. Grew team from four existing engineers to team of over 30 on immediate team and over 40 on project. Delivered new platform in one year. Platform and derivatives accounted for large portion of booked products for the division within 2 years and is currently (2008) a key portion of new product offerings.
- 2000: Empirix was formed as a spin-out of Teradyne in January 2000. Reported to CEO in carve-out of Empirix from Teradyne.
- 1999: (Teradyne) Director of Business Development, Software Test Units. Reported directly to Chairman of the Board/Founder and then to general manager of software test unit (6 divisions of Teradyne). Evaluated and researched acquisition and partnership candidates. Internally assessed technology position in market and gaps in product lines. Worked with senior division staff to develop new product strategies. Attended internal Teradyne divisional board meetings. Chairman served as my mentor.

3Com Corporation/NBX Corporation

- 1999: Software Engineer 5. Continued work after 3Com acquisition of NBX. Built cross-division relationships for new products and research directions. NBX was acquired by 3Com in March 1999.
- 1997 - 1999: (NBX) Senior Scientist and Engineer. Work in IP Telephony. Architected next-generation product. Protocol design and validation for core protocol now used tens of millions of times daily. Led team in integration of IP protocols into current product. Designed audio reconstruction algorithms. Developed applications for bug analysis and diagnosis of system problems. Implementation of network simulator. Work on collaborative projects with external

partners. Worked to identify gaps in product. Representative at numerous trade shows. Innovated novel methods of using product.

MIT Department of Electrical Engineering and Computer Science, Cambridge, MA

- 1991 - 1998: Research assistant, Telemedia Network Systems Group. Design, development, and implementation of Gigabit ATM network for distributed multimedia system. Studied host interface design issues. ATM network simulation.
- Spring 1989, Fall 1990, Spring 1995: Teaching assistant, Computation Structures digital systems course. (Spring 1995 Head TA)
- 1988 - 1989: Head laboratory teaching assistant for Computation Structures. Responsibilities included writing and revising lab assignments, and maintaining the lab.
- 1987: Laboratory teaching assistant for Computation Structures.
- 1987: Design, construction, and programming of 16-bit computer.

Agora Technology Group, Incorporated

- 1994 - 1996: Founder and CEO. Conceived and oversaw development of targeted advertising-supported Web sites. Responsible for company's vision and direction. Attended the first two WWW Conferences, presenting a workshop and paper at the first, and appearing on the "Commercialization and Economics of the Web" panel and chairing the "Where Commercial Services and the Web Are Headed" panel at the second. Sold company intact; is currently an operating stand-alone company.

AT&T Bell Laboratories, Holmdel, NJ

- 1989 - 1990: Implementation of cascadable all-optical fiber logic gate. Modelocking of all-fiber erbium laser. Construction of modelocked laser repetition rate booster. Strong optics laboratory and fiber optic experience.
- Summer 1988, 1987: Research in integrated optics. Analysis of rectangular waveguides using microwave modeling. Fabrication of integrated optical components.

Honors

- MIT Alumni Association Great Dome Award, 2010, Baker 60th Anniversary Reunion Co-Chair (highest group award given by MIT Alumni Association)
- MIT Alumni Association Presidential Citation Award (now known as Great Dome), 2008, Member of MIT Chairman's Salon committee
- MIT Alumni Association Bronze Beaver Award, 2007 (highest individual award given by MIT Alumni Association)
- MIT Alumni Association Volunteer Honor Roll, February 2004
- MIT Alumni Association Lobdell Award, 1999
- Boston Museum of Science Gold Pin for 1000 hours of Volunteer Service, April 1999
- MIT Alumni Association Presidential Citation Award (now known as Great Dome), 1997, Member of Alumni Online Communications Committee

Patents and Patent Publications

- U.S. Patent #9,697,231, H. Houh, J. Stern, R. Spina, M. Meter, “Methods and apparatus for providing virtual media channels based on media search,” July 4, 2017.
- U.S. Patent #9,697,230, H. Houh, J. Stern, “Methods and apparatus for dynamic presentation of advertising, factual, and informational content using enhanced metadata in search-driven media applications,” July 4, 2017. See also WO2007056485.
- U.S. Patent #7,975,296, L. Apfelbaum, H. Houh, T. Mayberry and G. Friedman, “Automated security threat testing of web pages,” July 5, 2011. See also US20030159063, WO2003067405.
- U.S. Patent #7,877,736, H. Houh and J. N. Stern, “Computer language interpretation and optimization for server testing,” January 25, 2011. See also US20050138104, WO2005043300.
- U.S. Patent #7,801,910, H. Houh and J. N. Stern, “Method and apparatus for timed tagging of media content,” September 21, 2010. See also US20070112837, US20090222442, WO2007056535.
- U.S. Patent #7,590,542, D. C. Williams, W. C. Hand, H. Houh, A. R. Seeley, “Method of Generating Test Scripts Using a Voice-Capable Markup Language,” September 15, 2009. See also EP1530869, US20030212561, WO2003096663.
- U.S. Patent #6,967,963, H. H. Houh, P. Anderson, C. Gadda, “Telecommunication method for ensuring on-time delivery of packets containing time-sensitive data,” November 22, 2005. See also EP1060400, WO2000033092, CA2318774.
- U.S. Patent #5,144,375, M. C. Gabriel, H. H. Houh, N. A. Whitaker, “Sagnac Optical Logic Gate,” September 1, 1992. Also issued as European Patent # EP0456422, July 23, 1997, German Patent #DE69126913, August 28, 1997
- U.S. Patent Application Publication No. 20020015387, “Voice Traffic Packet Capture and Analysis Tool for a Data Network” (Abandoned in 2007)
- U.S. Patent Application Publication No. 20020016708, “Method and Apparatus for Utilizing a Network Processor as Part of a Test System” (Abandoned in 2007)
- U.S. Patent Application Publication No. 20020016937, “Method and Apparatus for Utilizing a Network Processor as Part of a Test System.” (Abandoned in 2007) See also WO2002011413.
- U.S. Patent Application Publication No. 20070106646, “User-directed navigation of multimedia search results” (Abandoned in 2009)
- U.S. Patent Application Publication No. 20070106660, “Method and apparatus for using confidence scores of enhanced metadata in search-driven media applications” (Abandoned in 2009)
- U.S. Patent Application Publication No. 20070106685, “Method and apparatus for updating speech recognition databases and reindexing audio and video content using the same” (Abandoned in 2015)
- U.S. Patent Application Publication No. 20070118873, “Methods and apparatus for merging media content” (Abandoned in 2015)
- U.S. Patent Application Publication No. 20090222442, “User-directed navigation of multimedia search results” (Abandoned in 2016)
- U.S. Patent Application 11/395,732, “Search snippet creation for audio and video data” (Abandoned in 2009)
- U.S. Patent Application 11/774,931, “Methods and apparatus for managing a social networking web site”
- U.S. Patent Application 11/774,947, “Methods and apparatus for organizing media files”
- U.S. Patent Application 11/774,956, “Methods and apparatus for managing an online event”

- U.S. Provisional Patent Application 61/086,909, “Measuring and ranking relationship activity”
- U.S. Provisional Patent Application 61/086,914, “Detecting media object commonality”
- U.S. Provisional Patent Application 61/086,904, “Message categorization based on message characteristics”
- U.S. Provisional Patent Application 61/086,905, “Photo tagging to request action”

Publications

- “IP switching: server driven flow classification,” H. H. Houh, *Proceedings of the Washington University Workshop on Integration of IP and ATM*, November 1996.
- “Aurora at MIT,” D. D. Clark, H. H. Houh, and D. L. Tennenhouse, Editors, *MIT Laboratory for Computer Science Technical Report 673*, December 1995.
- “ViewStation Applications: Implications for Network Traffic,” C. J. Lindblad, D. Wetherall, W. Stasior, J. F. Adam, H. H. Houh, M. Ismert, D. Bacher, B. Phillips, and D. L. Tennenhouse, *IEEE Journal of Selected Areas in Communications*, 1995.
- “The VuNet Desk Area Network: Architecture, Implementation, and Experience,” H. H. Houh, J. F. Adam, M. Ismert, C. J. Lindblad, and D. L. Tennenhouse, *IEEE Journal of Selected Areas in Communications*, 13 (4), May, 1995.
- “Reducing the Complexity of ATM Host Interfaces,” H. H. Houh and D. L. Tennenhouse, *Hot Interconnects II Symposium Proceedings*, Stanford, August 11-12, 1994.
- “Media-intensive data communications in a ‘desk-area’ network,” J. F. Adam, H. H. Houh, M. Ismert, and D. L. Tennenhouse, *IEEE Communications*, August 1994.
- “ViewStation Applications: Intelligent Video Processing Over A Broadband Local Area Network,” C. J. Lindblad, D. J. Wetherall, W. Stasior, B. Phillips, D. Bacher, J. Adam, H. Houh, M. Ismert, and D. L. Tennenhouse, *Proceedings of the 1994 USENIX Symposium on High-Speed Networking*, Oakland, CA, August 1994.
- “The Media Gateway: Live Video on the World Wide Web,” H. H. Houh, C. J. Lindblad, J. Soo, D. L. Tennenhouse, and D. J. Wetherall, *Workshop at the 1994 World Wide Web Conference*, Geneva, Switzerland, May 1994.
- “Active Pages: Intelligent Nodes on the World Wide Web,” H. H. Houh, C. J. Lindblad, and D. J. Wetherall, *Proceedings of the 1994 World Wide Web Conference*, Geneva, Switzerland, May 1994.
- “Wavelength Division vs. Code Division Access Methods for Optical Networks,” H. H. Houh, *Area Exam Paper*, May 1993.
- “Experience with the VuNet: A Network Architecture for a Distributed Multimedia System,” J. F. Adam, H. H. Houh, D. L. Tennenhouse, *Proceedings of the 18th Conference on Local Computer Networks*, pp. 70-76, September 1993
- “The VudBoard: A Simple DMA Interface,” H. H. Houh, *Proceedings of the 4th Gigabit Minijam*, January 1994.
- “A Software-Oriented Approach to the Design of Media Processing Environments,” D. L. Tennenhouse, J. Adam, D. Carver, H. Houh, M. Ismert, C. Lindblad, W. Stasior, D. Weatherall, D. Bacher, and T. Chang., submitted to the *International Conference on Multimedia Computing and Systems*, May 1994.
- “A Network Architecture for Distributed Multimedia Systems,” J. F. Adam, H. H. Houh, M. Ismert, and D. L. Tennenhouse, submitted to the *International Conference on Multimedia Computing and Systems*, May 1994.

- “The Viewstation Collected Papers,” D. L. Tennenhouse, J. Adam, C. Compton, A. Duda, D. Gifford, H. Houh, M. Ismert, C. Lindblad, W. Stasior, R. Weiss, D. Wetherall, D. Bacher, D. Carver, and T. Chang, MIT Laboratory for Computer Science Technical Report, MIT/LCS/TR-590, November 1993.
- “The Viewstation Collected Papers II,” W. F. Stasior, D. L. Tennenhouse, J. F. Adam, D. R. Bacher, H. H. Houh, M. Ismert, C. J. Lindblad, B. M. Phillips, D. J. Wetherall, MIT Laboratory for Computer Science Technical Report, MIT/LCS/TR-696, April 1996.
- “A System's Perspective of the Sagnac Fiber Logic Gates and Their Possible Applications,” A. Huang, N. Whitaker, C. Gabriel, H. Avramopoulos, P. M. W. French, H. H. Houh, and I. Chuang, Applied Optics, September 10, 1994
- “Complete Switching in a Three-Terminal Sagnac Switch,” H. Avramopoulos, P. M. W. French, M. C. Gabriel, H. H. Houh, N. A. Whitaker, T. Morse, IEEE Phot. Tech. Lett. **3** (3), 235
- “Complete Switching in a Three-Terminal Sagnac Switch,” H. Avramopoulos, P. M. W. French, M. C. Gabriel, H. H. Houh, N. A. Whitaker, IEEE/LEOS Annual Meeting, Paper PDP-13, November 1990
- “All-optical phase-locked oscillator,” N. A. Whitaker, Jr., H. H. Houh, H. Avramopoulos, T. F. Morse, IEEE/LEOS Annual Meeting, Paper ELT2.4/MOO3, November 1990
- “Passive modelocking of an all-fiber erbium laser,” H. Avramopoulos, H. H. Houh, N. A. Whitaker, M. C. Gabriel, T. F. Morse, IEEE/LEOS Conference on Optical Amplifiers and their Applications, Paper PDP-8, August 1990
- “Transverse modes, waveguide dispersion, and 30ps recovery in submicron GaAs/AlAs microresonators,” J. L. Jewell, S. L. McCall, A. Scherer, H. H. Houh, N. A. Whitaker, A. C. Gossard, and J. H. English, Appl. Phys. Lett. **55** (1), July 3, 1989

Leadership, Activities and Interests

- Leadership
 - Reading Symphony Orchestra
 - Board of Directors (Treasurer), 2022 – present
 - Discovery Museum (Acton, MA)
 - Board of Directors, 2023 – present
 - Board of Directors, Development Committee, 2023 – present
 - Science and Technology Advisory Council, 2012 – present
 - The Discover Museum received the 2024 National Medal for Museum and Library Service, the nation’s highest honor given to museums and libraries that make significant and exceptional contributions to their communities.
 - Tau Beta Pi National Engineering Honor Society
 - Executive Councilor and Secretary, 2024 – 2026
 - Advisor, MA B Chapter at MIT, 2003 – present
 - District Director (National Officer), Tau Beta Pi, New England Area, 1991 – 2003
 - President, MA B Chapter at MIT, Fall 1988 – Spring 1989
 - Laureate award, 1989
 - MIT Alumni Association Board of Directors
 - MIT Annual Giving Board, 3 year term, 2024 – 2027
 - National Selection Committee, 3 year term, 2020 – 2023
 - K-12 STEM Initiatives Co-chair, 2013 – 2017
 - Awards Committee Chair, 2012 – 2014

- Awards Committee, 3 year term, 2011 – 2014
- Vice President, 2 year term, 2004 – 2006
- Alumni Ad-Hoc Committee, Chair, 2005-2006
- Board Member, 2 year term, 1997 – 1999
- MIT Club of Boston
 - Board of Directors, 2006 – 2011
 - K-12 Initiatives Chair, 2009 – 2012
 - VP of Communications, MIT Club of Boston, 2003 – 2006
 - Past-President, MIT Club of Boston, 2002 – 2003
 - President, MIT Club of Boston, 2001 – 2002
 - President-Elect, MIT Club of Boston, 2000 – 2001
 - VP of Programs, MIT Club of Boston, 1999 – 2000
 - Activities Super-Chair, MIT Club of Boston, 1998 – 1999
- MIT Enterprise Forum of Cambridge, Inc.
 - Past Chair, 2009 – 2011
 - In-NOW-vation Co-chair, 2010
 - Chair, 2007 – 2009
 - Vice Chair, 2005 – 2007
 - Executive Board Member, 2002 – 2011
 - Winter Workshop Co-Chair, February 2007 – conceived idea for conference, which sold-out and produced largest attendance numbers in recent memory
 - Spring Workshop Co-Chair, Spring 2004
 - Membership Committee Chair, Fall 2003 - 2006
 - 25th Anniversary Dinner Chair, Fall 2003
 - As Membership Chair and Board Member, started Special Interest Groups in 2004; a SIG won the MIT Presidential Citation award, the MIT Alumni Association's highest award for organizations, in 2006
- Estabrook Elementary School PTA
 - Advisory committee to the superintendent on PCB issue, 2010-2011
 - 4th Grade after-school science program co-organizer, 2010-2012
 - 4th and 5th Grade before-school Math Olympiad co-organizer, 2009-2013
 - 5th Grade BBQ and Yearbook Committee, 2011, 2013
 - Family Math Night volunteer, 2008-2012
- MIT Class of 1989
 - Class Agent, 2024 – present
 - 35-year Reunion Gift Committee, Co-chair, 2024
 - Secretary, five consecutive 5 year terms, 1989 – 2014
 - 30-year Reunion Committee, 2019
 - 25-year Reunion Committee, 2014
 - 20-year Reunion Committee and Gift Committee, 2009
 - 15-year Reunion Committee and Gift Committee, 2004
 - 10-year Reunion Committee and Gift Committee, 1999
 - 5-year Reunion Committee, 1994
 - Interim Treasurer, 1993 – 1994
 - Instituted annual senior class career fair, now raising over \$100,000 annually for senior class activities, Fall 1988
- Strong, consistent record of leadership dating to high school
- Acting

- ‘21’ (Sony Pictures), credited as “Chinatown Dealer,” 2007, Kevin Spacey's movie about the MIT Blackjack Team inspired by “Bringing Down the House” by Ben Mezrich, opened nationwide on March 28, 2008. 21 was the number one movie in US for two weeks and number one globally for one week. 21 also topped the DVD sales, Blu-ray sales and DVD rental charts.
- Spring Lake Theater Company, first New York-area off-broadway production of “A Chorus Line,” played role of Mark, Summer 1990
- Former member of the MIT Blackjack team
- Producer for 10,000 Maniacs’ 2013 album “Music from the Motion Picture”
- Executive Producer for 10,000 Maniacs’ 2015 album “Twice Told Tales”
- Producer for 10,000 Maniacs’ 2016 DVD “10,000 Maniacs Live”
- Executive Producer for OK Go’s 2025 album “And The Adjacent Possible”
- 2024-25 production of “Romeo & Juliet” at the Circle in the Square Theater, nominated for 2025 Tony for Best Revival of a Play, Investor
- Violist, violinist, cellist, harpist, guitarist, singer, actor: played in many amateur/semi-professional groups including Firebird Pops Orchestra, Boston Civic Symphony Orchestra, Reading Symphony Orchestra, MIT Summer Philharmonic Orchestra, Carlisle Chamber Orchestra, Horizon Ensemble, Rivers Symphony Orchestra, Opera51 Orchestra, American Music Abroad Summer 2025 Tour, Freisinger Chamber Orchestra, Merrimack Valley Philharmonic, Longwood Symphony, MIT Symphony, and Somerville Community Chorus
- Violist, “Coming Home” album by Karen Phillips, 2014
- Google Scholar citations: 2224, h-index: 22, i10-index: 27 (since 2019: 539/12/12)
- Erdos-Bacon number of 7
- Erdos-Bacon-Sabbath number of 11