

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SMAXTEC INC. and
SMAXTEC ANIMAL CARE GMBH,
Petitioners

v.

ST REPRODUCTIVE TECHNOLOGIES, LLC,
Patent Owner.

Case IPR2024-01067
Patent No. 10,231,644

**DECLARATION OF EDWIN C. KAN, PH.D. IN SUPPORT OF PATENT
OWNER RESPONSE**

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I. INTRODUCTION

1. My name is Dr. Edwin C. Kan. I have been retained by ST Reproductive Technologies, LLC (the “Patent Owner” or “ST Repro”) as an independent expert consultant in this *inter partes* review (“IPR”) proceeding before the United States Patent and Trademark Office. I am the same Dr. Edwin C. Kan who previously provided a declaration submitted as Exhibit 2001 in this matter. I was retained in this matter by ST Repro to review U.S. Patent No. 10,231,644 (the “’644 Patent”) and provide analysis, opinions, and observations in relation to the ’644 Patent and IPR2024-01067.

2. I am being compensated at my standard rate of \$400 per hour. My compensation is not contingent in any way on the outcome of this matter, substance of my testimony, or any of the positions I have taken, as provided below. Although I am being compensated at my standard consulting rate for the time I spend on this matter, I have no personal financial interest in any of the entities involved in this proceeding.

3. For this declaration, I have been asked to review and respond to statements made in the Petition filed in IPR2024-01067 and to the opinions provided in the Declaration of Professor Darrin J. Young (Ex. 1002) filed in connection with the Petition. I understand Professor Young is the expert witness engaged on behalf of Petitioners. I have also been asked to consider and provide my opinions regarding

the references Petitioners assert against the '644 Patent, and to compare those references to the claims of the '644 Patent that have been challenged in the Petition. My opinions and the basis for those opinions are outlined below. The testimony I may provide about scientific principles relating to my analysis and opinions includes subjects relating to, for example, boluses, sensors, transmitters, and the use of radiofrequency devices in animals.

4. I reserve the right to revise or supplement my opinions if additional information makes either appropriate, or if Petitioners or Professor Young revise or supplement their allegations or opinions.

II. QUALIFICATIONS AND BACKGROUND

5. My qualifications are stated more fully in my curriculum vitae, which is attached as Exhibit 2002 and incorporated by reference within this declaration. The following is a brief summary of my qualifications.

6. I received a Bachelor of Science (B.S.) degree in Electrical Engineering from National Taiwan University in 1984. I then received a Master of Science (M.S.) degree in Electrical and Computer Engineering from the University of Illinois at Urbana-Champaign in 1988. I further received a Doctorate (Ph.D.) in Electrical and Computer Engineering from the University of Illinois at Urbana-Champaign in 1992, with my thesis titled "Numerical models for the simulation of nonstationary effects in submicron semiconductor devices."

7. In January 1992, I joined Dawn Technologies in Sunnyvale, California as a Principal Computer-Aided Design (“CAD”) Engineer, developing advanced electronic and optical device simulators and technology CAD frameworks. In 1994, I began working at Stanford University in Palo Alto, California as a Research Associate in the Center for Integrated Systems, where I performed research on technology CAD and numerical methods.

8. In 1997, I joined the School of Electrical and Computer Engineering at Cornell University in Ithaca, New York, where I have held various roles since. Specifically, from 1997 to 2002, I was an Assistant Professor, where I performed research on CMOS circuits and technology. The application areas include flash memory, molecular sensors, transmission lines, and autonomous microsystems.

9. During the summers of 2000 and 2001, I also worked at the IBM Thomas J. Watson Research Center (then, known as the Thomas J. Watson Lab) in Yorktown Heights, New York as a member of the Faculty Partner Program. The Thomas J. Watson Research Center is the global headquarters for IBM Research, the largest industrial research organization in the world. In this program, I performed research in CMOS technology development, including the modeling of subthreshold leakage currents due to band-to-band tunneling, and asymmetric source-drain transistor structures. I also participated in IBM’s RF CMOS research, aiming at ultra-low-power design principles.

10. From 2002 to 2009, I was an Associate Professor in Cornell University's School of Electrical and Computer Engineering. During that time, my work still focused on CMOS technology development and circuit designs. I have expanded my research to carbon-based nanostructures, including both nanotubes and fullerenes. I have also studied microsystem integration in insect cyborgs where complete control and communication modules were fitted on a moth for conceptual demonstration. I have investigated non-conventional communication modules such as Bragg pulse radios, nonlinear transmission lines, and nonvolatile computing in the baseband processing.

11. In 2004 and 2005, while on sabbatical leave from Cornell University, I was a Visiting Researcher with Intel Research in Santa Clara, California and a Visiting Professor with the Stanford University Electrical Engineering Department. At Intel Research, I worked on phase-change memories, molecular sensors and carbon nanostructures integration in CMOS. As a Visiting Professor with Stanford University, I participated in research of CMOS technology development and radio-frequency IC designs, in particular modules by Bi-CMOS processes.

12. In 2009, I became a Professor in Cornell University's School of Electrical and Computer Engineering, and I presently serve in that role. In this role, I have taught courses in radio-frequency identification (RFID), RF systems, digital VLSI design, CMOS fabrication, numerical methods and software engineering. I

have also conducted research in RFID, in particular for precision localization and multiplexing protocols, RF systems for low data rate and ultra-low-power consumption, RF sensors, animal vital-sign sensing, and biomedical diagnosis. From 2010 to 2013, I also served as the Director of Graduate Studies for the School of Electrical and Computer Engineering, where I was responsible for graduate admission and supervised annual reviews of graduate students.

13. I have worked with many collaborators for animal sensing, both for veterinary medicine and biomedical animal models. I have worked with farm animals, pets, and wild lives from small betta fish to large sea elephants. I have worked with dairy farms on respiratory and digestive sensing using the wearable radio biosensors invented in my group. I have given invited talks in conferences on radio biosensors and RFID networks.

14. I have authored or co-authored more than 300 journal and conference papers, including approximately 150 papers on topics related to radio frequency sensing, actuators, sensor systems, biosensors, antennas, near-field radio frequency, RFID tag tracking, animal monitoring, and wireless protocols.

15. I have worked on more than 50 sponsored research projects, including approximately 25 projects in the areas of radio frequency sensing, sensor systems, biosensors, antennas, near-field radio frequency, RFID tag tracking, and wireless protocols.

16. I am the inventor or co-inventor on 15 issued U.S. patents, one U.S. patent application, and five U.S. provisional patent applications. A full list of my patents and patent applications is included in Exhibit 2002. I was honored by Cornell University in 2003 and 2006 with the Cornell Inventor Award.

17. I have worked on both hardware and software in a complete sensor system, conducting design, fabrication, signal processing, machine-learning based analysis, human studies and animal testing. Additional details about my education, work experience, awards and honors, and publications that may be relevant to the opinions I have formed in this declaration are set forth in my CV (Ex. 2002).

III. MATERIALS CONSIDERED

18. My opinions are based on my years of education, research, and experience, as well as my investigation and study of relevant materials. In forming my opinions, I have considered the materials I identify in this declaration and those listed in the table of exhibits below:

Exhibit No.	Description
1001	U.S. Patent No. 10,231,644
1002	Declaration of Professor Darrin J. Young
1003	CV of Professor Darrin J. Young
1004	Int'l Appl. No. PCT/US2007/020918, Pub. No. WO 2008/108816 ("Harvey")
1005	U.S. Patent Appl. Pub. No. 2009/0187392 ("Riskey")

1006	U.S. Patent Appl. Pub. No. 2013/0197323 (“Rettedal”)
1007	Japanese Patent Appl. No. 2004-215061 A (“Kunda”)
1008	U.S. Patent No. 6,371,927 B1 (“Brune”)
1009	U.S. Patent Appl. Pub. No. 2009/0030279 A1 (“Zander”)
1010	Prosecution History of U.S. Patent No. 10,231,644
1011	U.S. Patent No. 5,482,008 (“Stafford”)
1012	U.S. Patent No. 8,640,712 B2 (“Ardrey, Jr.”)
1013	“RUM_023 Administration of a Rumen Bolus”, UQ Animal Ethics Committee – Standard Operating Procedure
1014	U.S. Patent 9,413,585 B2 (“Schulzrinne”)
1015	U.S. Patent 10,594,335 (“Zrilic”)
1016	U.S. Patent Appln. Pub. No. 2023/0274893 A1 (“Andree”)
1017	2024-05-15 Preliminary Pretrial Conference Order (D.I. 034)
1018	2024-04-23 Plaintiff’s First Amended Complaint (D.I. 025)
1019	U.S. Patent Appln. Pub. No. 2003/0096637 A1 (“Keller”)
1020	Excerpt of Oxford Advanced Learner’s Dictionary of Current English, 9th ed. (2015)
1021	U.S. Patent No. 11,755,484 B2 (“Gray”)
1022	Int’l Appl. No. PCT/AU88/00225, Pub. No. WO 89/00024 (“Platt”)
1023	U.S. Appl. Pub. No. 2015/0277885 (“Kimoto”)
2003	U.S. Appl. Pub. No. 2010/0302039 (“Goto”)
2007	Deposition Transcript of Professor Darrin J. Young (April 1, 2025)

IV. LEGAL PRINCIPLES APPLIED

A. Person of Ordinary Skill in the Art

19. Some of my opinions refer to the perspective of one of ordinary skill in the art (“POSA”) at the time of the invention. I understand that the Patent Trial and Appeal Board (the “Board”) has issued an “Institution Decision” in this matter as Paper 7. In that decision, I understand that the Board determined that a POSA of the ’644 Patent would have had a bachelor’s degree in electrical engineering or a related or equivalent field, and three years of experience in researching, developing, designing, and/or evaluating sensor systems for humans or other animals. Paper 7, Institution Decision at 11-12. Based on the specific arguments and prior art asserted in the Petition and by Professor Young, I understand that ST Repro does not contest the Board’s determination as to the level of skill in the art for purposes of this proceeding. At ST Repro’s request, I have adopted and applied that definition herein solely for purposes of this proceeding, with the understanding that neither ST Repro nor I have undertaken an analysis of its accuracy, and that we both reserve the right to revisit its accuracy at a later date if necessary.

20. Based on the above criteria and my level of skill and personal experience in the field as of the priority date of the ’644 Patent, I consider myself a POSA and an expert in this area. I am also familiar with the understanding and

knowledge of a POSA as of the priority date. Thus, I understand the perspective of a POSA, which I have applied in my analysis in this declaration.

B. Claim Construction

21. I understand that the terms of a claim must be interpreted or “construed” and that, after such construction, the claims are then compared to the prior art for purposes of determining anticipation and/or obviousness.

22. I understand that patent claim terms are given their ordinary and customary meaning as would be understood by one of ordinary skill in the art. I further understand that the ordinary and customary meaning always applies unless a different meaning is clearly indicated by the patentee (such as by an express definition of a term in the patent specification or clear disclaimer of subject matter during prosecution).

23. Also, I understand that in determining the ordinary and customary meaning, the term should be read in light of “intrinsic” evidence, namely the patent specification and prosecution history. If intrinsic evidence is not sufficient to inform a person of skill of the ordinary and customary meaning of a term, “extrinsic” evidence may be consulted (e.g., a dictionary).

C. Anticipation

24. I have been informed and understand that a patent claim is invalid due to anticipation if a single prior art reference discloses every limitation of the claimed

invention. I understand that a claim is anticipated only if each and every limitation arranged as in the claim is found, either expressly or inherently described, in a single prior art reference.

25. I further understand that to anticipate the claimed invention, the prior art reference must be sufficiently “enabling,” that is, containing sufficient disclosures to enable a POSA to practice the subject matter based on the prior art reference without undue experimentation.

D. Obviousness

26. I understand that the prior art may render a patent claim “obvious.” I understand that obviousness is assessed from the view of a POSA at the time of invention. I understand that the prior art does not need to render obvious every possible embodiment within the scope of the claim. I further understand that in determining whether a patent claim is invalid because of obviousness, one must consider the scope and content of the prior art, the differences between the prior art and the claimed invention, and the level of ordinary skill in the art. To make these assessments, I understand that surrounding circumstances, like “objective indicia” or “secondary considerations” should be evaluated to the extent they exist.

27. I understand that an invention may be obvious because a skilled artisan pursues known options from a finite number of identified, predictable solutions, or because the claimed improvement is nothing more than the predictable use of prior

art elements according to their established functions. I understand that a claim is obvious if the POSA was motivated or had reason to combine the teachings of the prior art with a reasonable expectation of success. I also understand that obviousness does not require absolute predictability of success; only a reasonable expectation.

28. I further understand that obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness. Obviousness must be established by providing a sufficient explanation of how the references may be combined, from the perspective of one with ordinary skill in the art, to arrive at the claimed invention, and why the proffered combination accounts for all the features of each claim.

29. In particular, I understand that an obviousness theory must explain why a POSA would have combined elements from specific references in the way the claimed invention does.

V. THE '644 PATENT

A. The Patent Specification

30. The title of the '644 Patent is "Calf Bolus." Ex. 1001. The patent was filed on June 12, 2015 and issued on March 19, 2019. *Id.* I have used June 12, 2015 as the date of the invention throughout this declaration.

31. The Abstract of the '644 Patent and Field of the Invention explain that the patent relates to an “animal monitoring device configured as a bolus for oral administration to reside in the reticulorumen of a ruminant animal. The animal monitoring device includes a memory element, a processor in communication with the memory element and a computer code contained in the memory element. The computer code includes a power management module executable by the processor to regulate power use by the bolus.” Ex. 1001 at Abstract, 1:5-14.

32. The Background of the '644 Patent also describes three significant problems in the prior art, namely:

[1] Conventional boluses orally administered to reside in the reticulorumen for monitoring of physiological parameters of ruminant animals may not have a configuration capable of oral administration at birth. [2] Additionally, boluses even when orally administered to adult ruminant animals may not have an operational lifespan long enough to monitor useful physiological parameters over the remaining productive lifespan of the ruminant animal. [3] Moreover, uncontrollable changes in the orientation of the bolus and correspondingly uncontrolled orientation of the bolus antenna in the reticulorumen of the ruminant animal may cause variable quality in radio signal transmission from the ruminant animal resulting in the loss of encoded physiological data.

Ex. 1001 at 1:18-30.

33. The patent then explains that a “broad object of the invention can be to provide a bolus which can reside in the reticulorumen of a ruminant animal having

an operational lifespan corresponding to the entire lifespan or the productive lifespan of the ruminant animal.” *Id.* at 1:41-45. For example, one “aspect of this broad object of the invention involves a power management module pre-programmed or re-programmable to reconfigure the operating parameters of the bolus during residence in the reticulorumen of a ruminant animal to collect only useful physiological data and encode and transmit such physiological data at intervals based upon the life stage of the ruminant animal.” *Id.* at 1:59-66. Further, a “broad object of the invention can be to provide an antenna having a structure that alters the magnetic field and electrical field generation in a manner that reduces the impact of uncontrollable changes in the orientation of the bolus and correspondingly the orientation of the antenna during residence of the bolus in the reticulorumen of the ruminant animal.” *Id.* at 2:10-16.

34. The claims of the patent describe a “method of monitoring physiological parameters of a ruminant animal” by generating a sensor signal from “one or more sensors contained in a bolus orally administered” to the animal. *See id.* at claims 5, 9. The sensor signal, which “varies based on a corresponding change” in the animal’s physiological parameters, is transformed into “encoded physiological data” and then stored in a “non-transitory computer readable media.” *Id.* The bolus also contains a “radio signal generator” that is enabled and then activated to transmit a “radio signal to carry said encoded physiological data.” *Id.* In most of the claims,

the radio signal generator must be activated “at pre-determined intervals” to generate the radio signal carrying the encoded physiological data, and the radio signal has a frequency of “between about 700 MHz to about 1 GHz.” *Id.* at claim 5. In other claims, the radio signal is transmitted with an “antenna having a pair of electrically conductive loops disposed a distance apart.” *Id.* at claim 9.

35. In my opinion, the claimed inventions conserve energy usage of a bolus, extending the battery life and the operational life of the bolus, such that the bolus can monitor the physiological parameters of a ruminant animal over its entire productive lifespan. This is particularly useful when monitoring a cow, which may have a productive lifespan of around 5-6 years, making power savings critical for the bolus to remain operative while residing inside the cow’s reticulum the entire time. *See* EX. 1001 at 7:66-8:3

36. The patent also describes features, components, and functions that further enhance the performance of the bolus. For example, the bolus may include an antenna with two electrically conductive loops connected to the radio signal generator to transmit the radio signals, which I may refer to herein as a “double loop” antenna. EX. 1001 at 6:62-7:20; claims 9-10. The double loop antenna disclosed in the patent can address “uncontrollable changes in the orientation of the bolus and correspondingly uncontrolled orientation of the bolus antenna in the reticulorumen of the ruminant animal.” *Id.* at 1:25-31; *see id.* at 2:10-16, 7:32-33, Figs. 4-13. A

POSA would understand that the disclosed double-loop antenna has also less impedance change due to ambient dielectric changes due to the uncontrollable food intake. As the patent explains with reference to Figures 4-13, the disclosed double loop antenna can include “a first electrically conductive loop (32) electrically interconnected to a second electrically conductive loop (33),” which are together electrically connected to a radio signal generator, receiver or transceiver. *Id.* at 6:62-7:2. This “pair of electrically conductive loops” include, for example, a “conductive path” or “conductive layer” (e.g., made of copper) with an “inner annular edge” and an “outer annular edge” that join the “opposed loop faces.” *Id.* at 7:2-7. Additionally, the double-loop antenna can include a circuit board disposed between the two conductive loops with holes for electrically interconnecting the loops. *Id.* at 7:8-16. The holes are also configured to be electrically conductive, for example, by “electroplating, or by lining the hole with a tube or a rivet.” *Id.* at 7:17-20.

37. As the patent explains, “[t]here can be substantial advantages” in using the disclosed double loop antenna in the inventive methods of monitoring physiological parameters of a ruminant animal over its lifespan using a bolus. Ex. 1001 at 7:20-22; claims 9-10. First, it “increases the cross-section width of the antenna (28) which increases the stability of the radiated electrical field (41) of the antenna (28).” *Id.* at 7:22-25. Second, it “increases the bandwidth of the antenna (28) allowing shift in radio signal frequency (23) or attenuation resulting from

passing through the mass of the ruminant animal (3) to be more readily counteracted.” *Id.* at 7:25-29. Third, it “alters the magnetic field and electrical field generation which reduces the impact of uncontrollable changes in the orientation of the bolus (1) and correspondingly the orientation of the antenna (28) in the reticulorumen (5) of the ruminant animal (3).” *Id.* at 7:29-33.

38. The bolus sensor system design disclosed and claimed in the ’644 Patent has many differences from an ear tag (e.g., as described in the Harvey discussed below) or handheld cellular phone (e.g., as described in the Kunda reference discussed below), for example, in terms of matching elements, antennas, communication protocols and power management. The overall strategy is to achieve a long-term use of the bolus across the lifespan of a ruminant animal, which, for example, can be more than **7 years** for dairy cows in a **complex, unpredictable ambient** (due to the uncertain orientation and food intake in the reticulorumen of the ruminant animal. 644 provides a realizable full design with the given choices of radio transceivers, antennas and their matching elements, power management schemes and communication protocols with external readers.

39. The inventive bolus in the ’644 Patent may additionally include “matching elements” that function to “match the input impedance of the electrical load or the output impedance of the loads corresponding signal source to maximize the power transfer or minimize signal reflection from the load.” Ex. 1001 at 5:4-8;

Fig. 2; claims 5-7. “Signal reflection” occurs when a portion of a transmitted signal bounces back towards the source instead of reaching the intended receiver, often due to impedance mismatches or discontinuities in the transmission medium. Ideally, “source impedance and load impedance should be equal to maximize power transfer,” or maximize “gain,” which provides a phenomenon known as “resonance” in the system. *Id.* at 5:8-10, 5:61-64. In other words, ideally, the impedance of the radio signal generator (source) and antenna (load) should be equal in the real part and cancelled in the imaginary part to maximize power transfer and gain. As the patent explains, “[t]hree elements influence the balance of impedance in radio design: [a] the antenna (28) or ‘load’, [2] the radio signal generator (21) or ‘source’, and [3] the device’s ground plane.” *Id.* at 5:11-15. Because “each of these elements have different physical characteristics, their corresponding impedances are inherently different.” *Id.* at 5:15-17. As the bolus is in its own package embedded in the reticulorumen, the definition of the “ground plane” is thus affected by the dielectric ambient of the reticulorumen and the animal body where the bolus resides.

40. The disclosed “matching elements” are specifically a “resonant circuit” to shift the antenna resonant frequency “to a desired radio signal frequency” for “passing through the mass of the ruminant animal.” Ex. 1001 at 5:4-6:40. In particular, “[t]he matching elements (25) (*also referred to as the “resonant circuit”*) include an array of inductors (27) and capacitors (26) used in series or in parallel to

balance the circuit impedance once the impedance of the antenna (28), the radio signal generator (21), and the ground plane (not shown) are known.” Ex. 1001 at 39-45 (emphasis added). In the disclosed method of employing matching elements, “passive capacitors (26) and inductors (27) ... make up the matching elements,” and they “mitigate these differences and rebalance the impedance for a given radio signal frequency (23).” *Id.* at 5:17-20.

41. The patent further provides formulas for determining “impedance” of the “inductor” and “capacitor,” for determining the overall impedance of “resonant circuit” in series or parallel, and for determining the “reactance.” Ex. 1001 at 5:20-60. The patent further explains that “[r]esonance in the resonant circuit (25) occurs when the resonant circuit (25) is driven at a frequency ω_0 at which the inductive and capacitive reactances are equal in magnitude.” *Id.* at 5:61-64. It then provides a formula for determining “[t]he frequency at which this equality holds for the resonant circuit,” which “is called the resonant frequency.” *Id.* at 5:65-6:10. Thus, the patent provides formulas to “identify the inductors (27) and capacitors (26)” that can be “used as matching elements (25) in association with the radio signal generator (21) that operates at a specific radio signal frequency (23) to balance the impedance between the radio signal generator (21) and the antenna (28) and limiting the bandwidth to eliminate interference.” *Id.* at 11-24 (“After the signal passes through the matching elements (25) the resistance of the circuit can be altered to ensure an

industry standard of 50 Ohms resistance in the transmission line to the antenna (28) ... by inclusion of resistor (25A) to establish the standard 50 Ohms resistance in the circuit.”).

42. This realignment of the frequency between the oscillator-generated radio signals and the antenna center frequency improves power performance for the given output signal power. The design choice of the transmitter architecture, antennas, matching elements and communication protocols was made specifically for the use case of the bolus sensor in the reticulorumen to accommodate the strong and uncertain antenna detuning effects over the lifespan of the animal, and has unique system aspects different from the teaching of components in Harvey (e.g., ear tag), Risky (e.g., communication protocols), Rettedal (e.g., “match element”) and Kunda (e.g., “double-loop” antennas in cell phones).

43. Moreover, the '644 Patent explains how the inventors discovered a shift in “center frequency” caused by the placement of the bolus within the mass of the animal. As the patent states, “[b]ecause the radio signal generator (21) included in embodiments of the bolus (1) ***operate within the mass of a ruminant animal*** (3), it has been discovered that the center frequency (the arithmetic mean of the lower cutoff frequency and the upper cutoff frequency) is shifted lower and may not have the maximum gain.” Ex. 1001 at 6:27-32 (emphasis added). “Gain” refers to the efficiency of the antenna transmission, and maximum gain is achieved when “signal

reflection” from the antenna back to the source (e.g., the radio signal generator or oscillator) is minimized. The “center frequency” is an antenna characteristic together with the sensor ambient, and is realigned to the frequency of the signal generated by the radio signal generator (e.g., the oscillator (*see, e.g., id.* at 4:42-44, 6:41-45) through the matching elements. Thus, the claimed matching elements provide a “substantial advantage” by selecting and positioning “inductors (27) and capacitors (26) ... in the resonant circuit (25)” so as “to increase the inductance and capacitance values to purposefully shift the center frequency upward [as seen at the output of the oscillator] and allowing the radio signal frequency (23) to ... pass[] through the mass of the ruminant animal (3)” with the maximum efficiency. Ex. 1001 at 6:33-40. In other words, placing the bolus in the mass of the animal causes the resonant frequency to shift, and the matching elements shift the center frequency perceived at the output of the oscillator back so that the radio signal frequency from the oscillator will not face strong reflection when the bolus is placed inside the animal.

44. Moreover, Professor Young quotes a portion of the specification referring to “conventional boluses.” Ex. 1002 at ¶ 29 (citing Ex. 1001 at 1:18-30). I disagree to the extent Professor Young is suggesting that the methods claimed in the ’644 Patent consist of conventional components. The claims comprise specific

components arranged in unconventional ways, as demonstrated by my comparison of the claims to Petitioners' asserted art below.

45. When the patent uses the word "conventional," a POSA would understand that it is clearly describing prior-art boluses only, and not any aspect of the claimed invention. The full context of the statement that Professor Young quotes, which is the first sentence of the "BACKGROUND OF THE INVENTION" section of the patent is as follows:

Conventional boluses orally administered to reside in the reticulorumen for monitoring of physiological parameters of ruminant animals may not have a configuration capable of oral administration at birth.

Ex. 1001 at 1:18-21. This would not suggest to a POSA that the claimed methods are conventional in any way. In fact, as I explained above, the background describes significant problems with such prior art and then explains that the disclosed inventions solve those problems. *See* Ex. 1001 at 1:18-2:16.

B. The Challenged Claims

46. The Petition challenges claims 5-7, 9, 10, and 13 of the '644 Patent. I understand that claim 13 of the '644 Patent has been disclaimed by ST Repro. Therefore, I do not address claim 13 or Grounds 6 and 7, which challenge claim 13, in this declaration.

47. Claim 5 is reproduced below. In the left column, I include a shorthand identifier for each "claim element," which I will refer to throughout this declaration.

5[Pre]	5. A method of monitoring physiological parameters of a ruminant animal, comprising:
5[A]	generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal,
5[B]	said sensor signal varies based on a corresponding change in one or more physiological parameters of said ruminant animal;
5[C]	encoding said sensor signal from said one or more sensors as encoded physiological data corresponding to said one or more physiological parameters of said ruminant animal; and
5[D]	storing said encoded physiological data in a non-transitory computer readable media,
5[E]	enabling a radio signal generator located within said bolus;
5[F]	activating said radio signal generator at pre-determined intervals to generate a radio signal to carry said encoded physiological data; and
5[G]	generating said radio signal having a frequency of between about 700 MHz to about 1 GHz.

48. Claim 6 recites:

The method of claim 5, wherein said frequency is selected from the group consisting of: between about 700 MHz to about 800 MHz, 750 MHz to about 850 MHz, about 800 MHz to about 900 MHz, 850 MHz to about 950 MHz, 900 MHz to about 1 GHz.

49. Claim 7 recites:

The method of claim 6, wherein said bolus further comprises matching elements which adjusts said frequency of said radio

signal to compensate for a change in said frequency of said radio signal due to passing through a mass of said ruminant animal.

50. Claim 9 is reproduced below. Again, I have included shorthand identifiers for claim elements.

9[Pre]	9. A method of monitoring physiological parameters of a ruminant animal, comprising:
9[A]	generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal,
9[B]	said sensor signal varies based on a corresponding change in one or more physiological parameters of said ruminant animal;
9[C]	encoding said sensor signal from said one or more sensors as encoded physiological data corresponding to said one or more physiological parameters of said ruminant animal;
9[D]	storing said encoded physiological data in a non-transitory computer readable media;
9[E]	enabling a radio signal generator located within said bolus;
9[F]	activating said radio signal generator to generate a radio signal to carry said encoded physiological data; and
9[G]	transmitting said radio signal with an antenna having a pair of electrically conductive loops disposed a distance apart and further comprising transmitting said radio signal through said antenna.

51. Claim 10 recites:

The method of claim 9, wherein said pair of electrically conductive loops each comprise a loop of conductive sheet

material having an inner annular edge and an outer annular edge which join opposed loop faces.

52. As I noted above, claims 6, 7, and 10 all depend on claims 5 or 9 and specify various additional limitations. Because the references asserted by Petitioners and Professor Young do not anticipate or render obvious independent claims 5 or 9, and I understand that all limitations of an independent claim are required in its dependent claims, I have focused my analysis below on claims 5 and 9.

53. For all the reasons herein, I disagree with Professor Young's opinion that any of the challenged claims are anticipated or obvious.

VI. CLAIM INTERPRETATION

54. In accordance with the standards for interpreting patent claim terms discussed above in Section IV.B, I have interpreted the claims based on their ordinary and customary meaning as understood by a POSA in view of the '644 Patent and its prosecution history.

VII. SUMMARY OF THE ASSERTED ART

A. Risky (Ex. 1005)

55. Risky is a U.S. patent application publication titled "System and Method for Monitoring a Health Condition of an Animal." As Petitioners and Professor Young acknowledged, Risky was presented to the Patent Office during prosecution of the '644 Patent, and the Examiner initialed the IDS to indicate that the reference was considered. See Petition ("Pet.") at 13; Ex. 1002 at ¶ 48 ("Risky

appears in the prosecution history of the '644 Patent in a September 23, 2015 IDS initialed by the examiner.”) (citing Ex. 1010 at 174, 203).

56. For Ground 2, Petitioners and Professor Young argue that Risky anticipates claims 5 and 6. For Ground 3, they argue that Harvey in combination with Risky renders obvious claims 5 and 6. As I will explain below, Risky fails to disclose a method of monitoring physiological parameters of a ruminant animal that includes each and every element of the challenged claims. As I will explain below, it is my opinion that Risky does not anticipate, or in combination with Harvey render obvious, any of the challenged claims.

57. Risky generally relates to “systems and methods for monitoring a health condition of an animal.” Ex. 1005 at Abstract, [0001], Figs. 1, 2. Unlike the invention in the '644 Patent, Risky does not describe transmitting animal physiological data at “pre-determined intervals.” Instead, Risky describes transmitting a message at a “transmission frequency” that depends entirely on specific triggering “events,” such as “changing animal health conditions” or a change in the animal’s “location.” Ex. 1005 at [0043], [0048]-[0049]. Risky explains that it is configured in this manner—i.e., to change frequencies based on events instead of at specified pre-determined intervals—so that such changes in the animal’s health or location may be recognized sooner. Ex. 1005 at [0048], [0142].

58. According to Petitioners and Professor Young, Risky describes two embodiments that relate to transmission interval/frequency: (i) “burst” mode, and (ii) “on-line” mode. Ex. 1005 at [0049], [0053]. Petitioners and Professor Young rely on both modes to argue that Risky discloses “activating said radio signal generator at pre-determined intervals to generate a radio signal to carry said encoded physiological data,” as required in claim 5. Pet. at 36-37; Ex. 1002 at ¶ 92-93. As I explain in more detail below for Ground 2, I disagree with Petitioners and Professor Young that these modes satisfy that claim limitation. See Section X. For example, the “burst” mode in Risky uses a “transmission interval” that is not pre-determined, but is instead dependent on the animal’s health conditions and triggering events that affect the delay applied between transmissions. *Id.* The purported “interval” in the “on-line” mode relates to transmissions of bolus identifiers useful for localization and polling, not the “encoded physiological data” required by claim 5. *Id.*

59. I have reviewed the descriptions of Risky and Harvey, and how they are characterized in the Petition and Professor Young’s declaration. Based on my review, I do not see that Petitioners or Professor Young have identified any distinctions between Harvey and Risky and what they contend is disclosed by the references. Petitioners and Professor Young appear to apply the same analysis for both references.

B. Harvey (Ex. 1004)

60. “Harvey” is a 78-page international patent publication titled “System and Method for Subject Management Using Intelligent RF Tag and Reader.” Petitioners and Professor Young rely on Harvey in Grounds 1 and 3-5. For Ground 1, they argue that Harvey anticipates claims 5 and 6. For Ground 3, they argue that Harvey in combination with Risky renders obvious claims 5 and 6. For Ground 4, they argue that Harvey in combination with Rettedal renders obvious claim 7. For Ground 5, they argue that Harvey in combination with Kunda renders obvious claims 9 and 10. As I will explain below, it is my opinion that Harvey fails to disclose a method of monitoring physiological parameters of a ruminant animal that includes each and every element of the challenged claims. Therefore, in my opinion, Harvey does not anticipate any of the challenged claims. It is my further opinion that Harvey in combination with Risky, Rettedal, or Kunda does not render any of the challenged claims obvious.

61. The challenging radio ambient conditions and operational requirements in the bolus sensor demands a thorough consideration of component selection and the associated integration, where ’644 Patent teaches a complete description of working devices, instead of speculation of possibilities.

62. A POSA would understand that Harvey is generally directed to a “subject management system” using an “intelligent active tag” (“IAT”) that is

Figure 1 of Harvey provides an illustration of the subject management system, depicting an IAT (e.g., 1100, 1111, 1112, and 1113) attached to the ear of an animal subject (e.g., 1010, 1011, 1012, and 1013). Figure 1 is reproduced below:

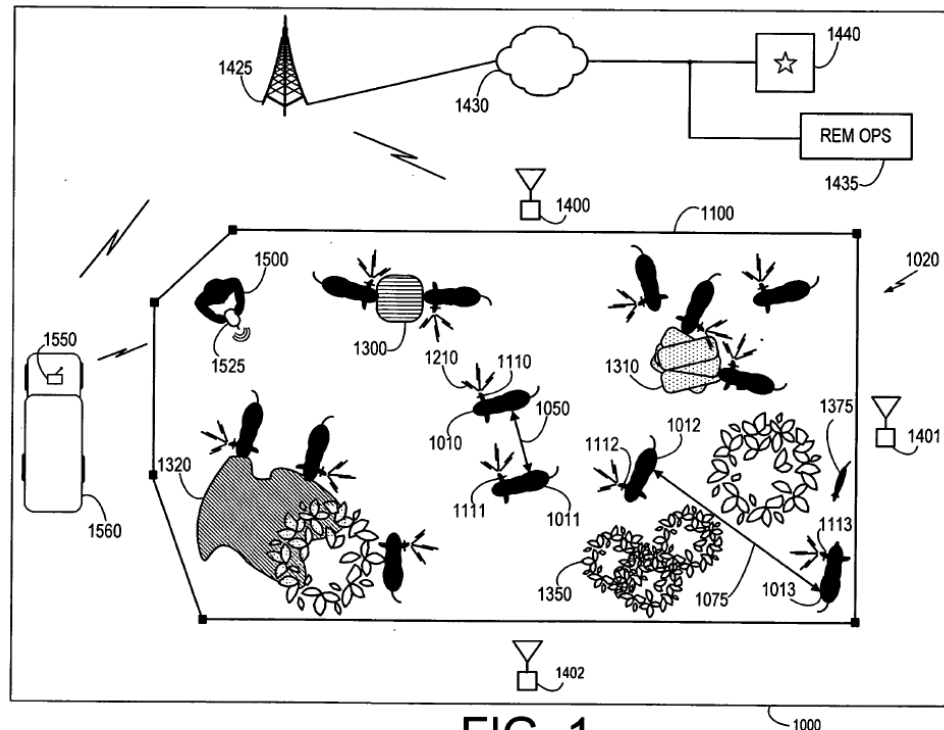


FIG. 1

Ex. 1004 at Fig. 1, 6:11-12; *see, e.g., id.* at 8:5-7, 11:8-10 (“[A]n active tag, such as IAT 1110, may be secured to monitored subject 1010 as a collar, bracelet, ring, or apparel, or as an ear tag, tail tag, or piercing stud.”), Fig. 3A (depicting an IAT affixed to an ear of cattle). The IAT includes a power source and transponder. Ex. 1004 at 18:3-17, 18:34-19:9.

63. Petitioners and Professor Young rely on the “intelligent transponder (XPDR)” embodiment designated as 5000 in Harvey’s figures and specification. Pet. at 18-27; Ex. 1002 at ¶ 57-75; Ex. 1004 at 22:29-30. Figure 5 is reproduced below and depicts a block diagram of the embodiment:

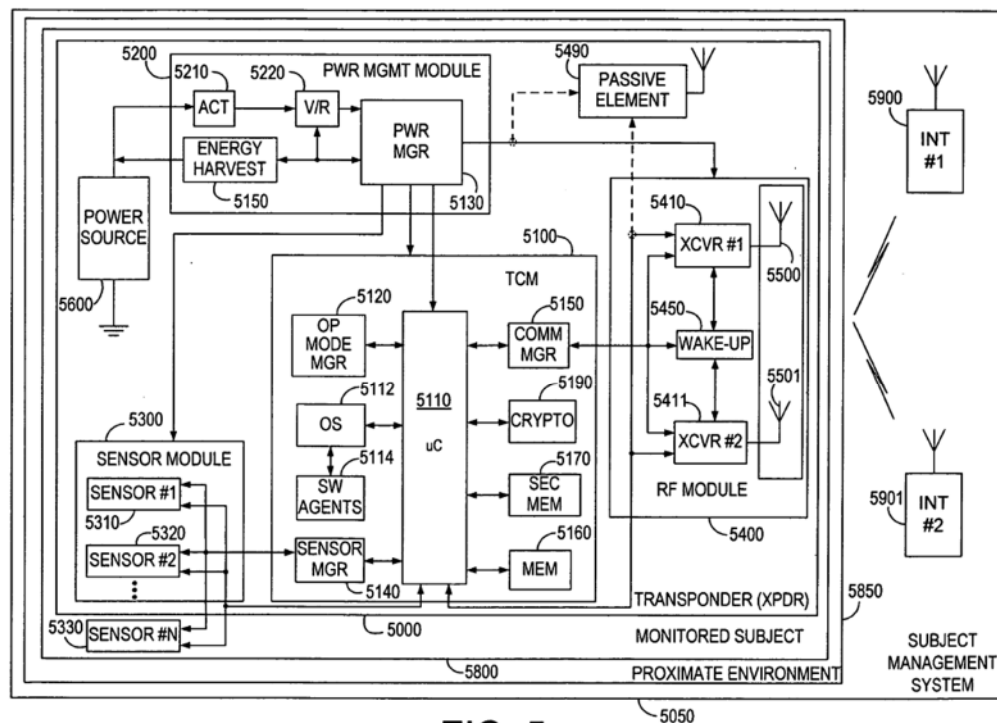


FIG. 5

Ex. 1004 at Fig. 5, 6:25-26, 22:29-30. The XPDR 5000 communicates with an interrogator (e.g., 5900). Ex. 1004 at 22:35-36.

64. Petitioners and Professor Young repeatedly refer to the XPDR 5000 transponder as a component of “Harvey’s bolus,” but a POSA reading Harvey would understand that the XPDR 5000 embodiment is only suitable in an external format, such as an ear tag, not an internal bolus. There is one conclusory reference to a “bolus” configuration in the 78-page disclosure, but that reference is not related to

XPDR 5000. Ex. 1004 at 11:8-13. While addressing potential IAT implementations, Harvey states that “an active tag, such as IAT 1110, may be secured to monitored subject 1010 as a collar, bracelet, ring, or apparel, or as an ear tag, tail tag, or piercing stud,” or “may be restrained or moveable within monitored subject 1010, for example, as a digestive tract bolus device, or as a miniature transponder lodged or secured within the circulatory system, bone, or soft tissue.” Ex. 1004 at 11:9-13. A POSA would understand this to mean that Harvey speculated the possible use case of bolus inside the animal (not specifically in reticulorumen but just an overall description of a digestive tract) without teaching how such a system can be implemented and optimized. But the XPDR 5000 embodiment that Petitioners and Professor Young rely on is never described as having an internal bolus configuration, nor would a POSA understand that the XPDR 5000 embodiment could be configured to operate in a bolus.

65. Every description of the XPDR 5000 transponder is as part of an external ear tag configuration. Harvey states that XPDR 5000 may be used as a “constituent element of multi-modal intelligent active tag 2000.” Ex. 1004 at 17:30-31, 22:29-30. As Harvey explains, “XPDR 5000 can be coupled to monitored subject 5800, for example, by intimate affixment, as described relative to FIG. 3.” Ex. 1004 at 22:30-33. Harvey further explains that a suitable tag for XPDR 5000 is

“tag 2000 in FIGS. 2 and 3.” Figure 2, for example, illustrates the three possible “form factors” of active tag 2000. Figure 2 is reproduced below:

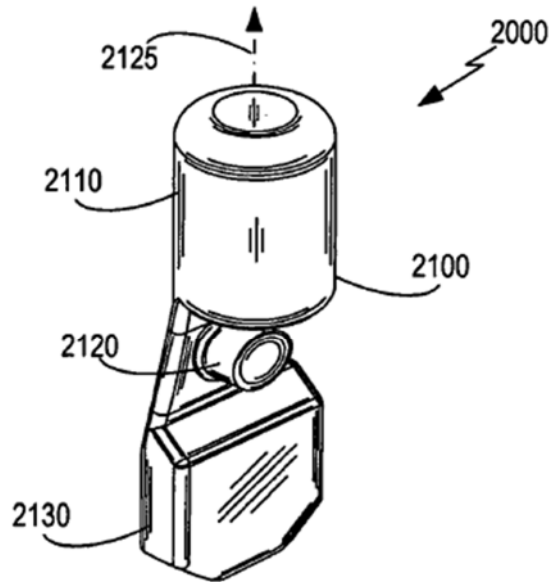


FIG. 2A

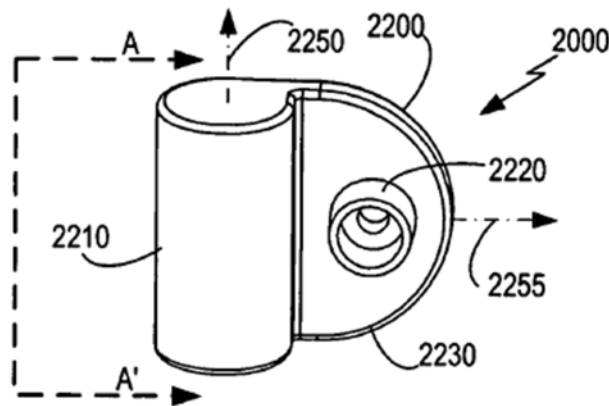


FIG. 2B

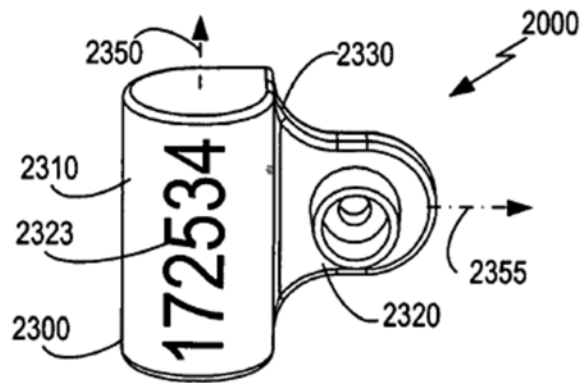


FIG. 2C

Ex. 1004 at Figs. 2A-2C, 17:29-30.

66. As detailed in Harvey, each form factor is an “ear tag” and includes an “affixment fitting” (e.g., 2120, 2220, and 2320) so the tag “may be affixed to the ear of monitored subject.” Ex. 1004 at 17:31-33, 18:3-17, Figs. 2A-2C (affixment fitting 2120, 2220, 2320). *See also id.* at 17:34-35 (“Tag 2000 also may be suitable for tag placement on another anatomical region of a subject member.”), 17:36-18:2 (“[T]he term intimate affixment may describe a manner by which tag 2000 may be coupled to monitored subject 1010 corpus, and in which at least a portion of tag 2000 may contact a portion of monitored subject 1010.”).

67. Figure 3 similarly illustrates the first form factor of tag 2000 “coupled to monitored subject 1010, by intimate affixment to a surface of cattle ear 3000,” exemplified by pinning to the ear, which “may facilitate sensing a monitored subject

parameter.” Ex. 1004 at 19:10-28. Specifically, Figure 3A is reproduced below and depicts the tag being affixed in an interior surface 3100 of cattle ear 3000:

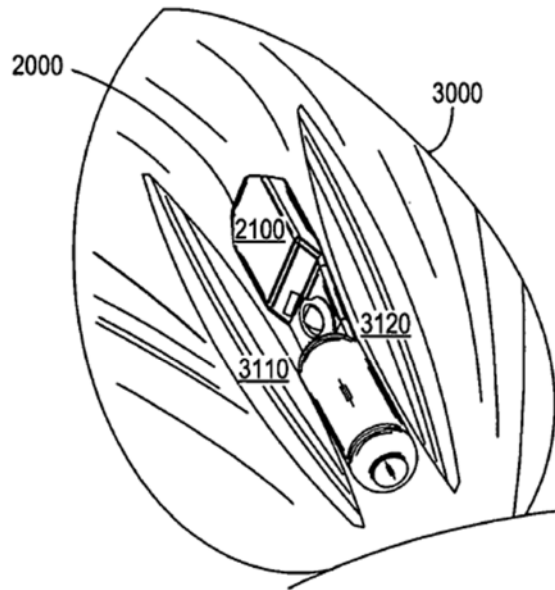
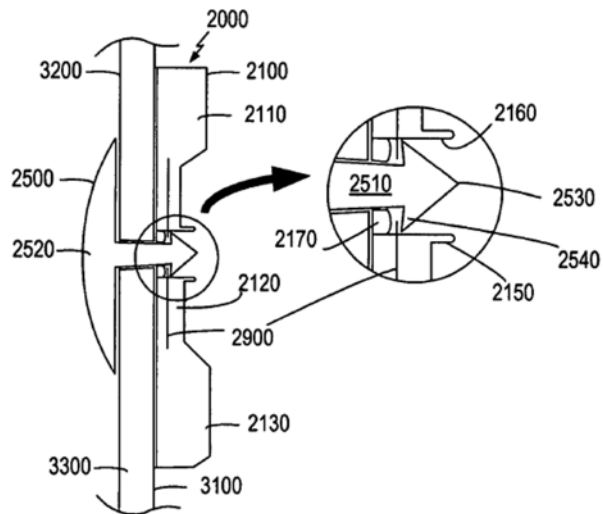


FIG. 3A

Ex. 1004 at Fig. 3A, 19:16-17. As Harvey explains, tag placement should be “a region affording visibility of the tag while avoiding permanent physical injury to the subject.” Ex. 1004 at 19:19-21. Figure 3B is reproduced below and further illustrates a cross section of the tag and tag placement depicted in Figure 3A:



Ex. 1004 at Figs. 3B, 19:16-23.

68. Petitioners and Professor Young assert that the different figures in Harvey are “interchangeable examples of the same device” and “the descriptions in the specification apply equally to the devices illustrated in any and all of those drawings.” Pet. at 11; Ex. 1002 at ¶ 43. I disagree. A POSA would have understood that the exterior ear tag disclosed in Harvey, and relied on throughout the Petition and by Professor Young, has many design aspects that are not suitable for a bolus. For example, as I will explain below in Section IX.A.2, many of the sensors included in the ear tag are not feasible in a bolus, such as the electrical sensors to measure EEG, ECG, or EMG waves, all of which need intimate contact to the designated skin electrodes, not in the environment of the digestive tract. *See also* Section VIII.A4 above. For the antenna design, the ear tag can assume one side is the outer ear tissue

and the other side is the free air, where the antenna detuning can be mitigated readily with ground-plane techniques. In contrast, the bolus tag antenna has to consider not only the detuning uncertainty of the dielectric ambient consisting of the food intake and digestive juices but also the possible scattering through many layers of living tissues. For the radio transceivers, the ear tag can be readily accessed by operators or remotely charged by external radio energy harvesting, so the power consumption requirement is less stringent than the bolus transceivers where access is denied and energy harvesting much more difficult due to the energy coupling deep inside the living animal. Therefore, Harvey does not suggest that its embodiments and descriptions are interchangeable between the ear tag and the bolus tag, contrary to Petitioners' and Professor Young's unsubstantiated assertion. Indeed, a radio signal generator operating inside the reticulorumen, as required by the challenged claims, has special design considerations, such as the type of antennas, as well as antenna impedance matching and power consumption as described further below, and is thus very different from the transponder in Harvey that is meant for an ear tag operating in free air with constant access to the system power source. In other words, the component choices (e.g., antennas and batteries) and other system design aspects (e.g., power consumption and communication protocols) of an internal bolus design are very different from those used for tags on the external body of an animal.

69. Notably, Harvey does not describe its “bolus” in any detail or suggest to a POSA that it could or would be used in connection with other disclosures in Harvey, such as with the XPDR 5000.

C. Rettedal (Ex. 1006)

70. Rettedal is a U.S. patent application publication titled “Animal Monitoring System.” As Petitioners and Professor Young acknowledged, Rettedal was presented to the Patent Office during prosecution of the ’644 Patent, and the Examiner initialed the IDS to indicate that the reference was considered. *See* Pet. at 14; Ex. 1002 at ¶ 52 (“Rettedal appears in the prosecution history of the ’644 Patent in a June 12, 2015 IDS initialed by the examiner.”) (citing Ex. 1010 at 163, 205).

71. Petitioners and Professor Young rely on Rettedal solely for claim 7. In particular, for Ground 4, they argue that Harvey in combination with Rettedal renders obvious claim 7. As I will explain below, it is my opinion that Rettedal in combination with Harvey does not render obvious claim 7.

72. Petitioners and Professor Young rely on Rettedal for only the “matching elements” limitation in claim 7. Pet. at 48-49; Ex. 1002 at ¶ 112-113. Petitioners and Professor Young rely solely on Harvey for the elements of claims 5 and 6, from which claim 7 depends, and they do not contend that Rettedal addresses Harvey’s deficiencies, presumably because Rettedal likewise fails to disclose or describe, at least, for example, the “activating a radio signal generator at pre-determined

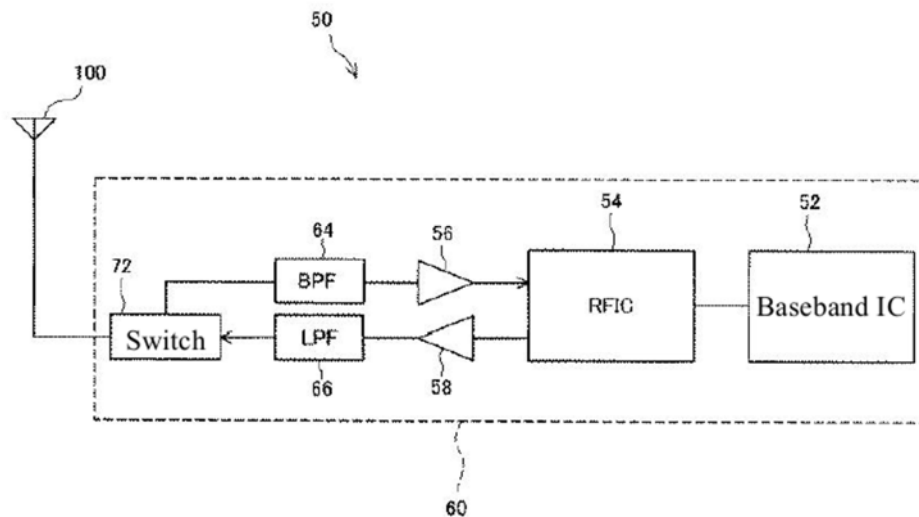
intervals” requirement in claim 5. *See* Pet. at 47-48; Ex. 1002 at ¶ 111; *see also* Sections IX.A-D for claim elements missing from Harvey and for which Petitioners and Professor Young do not rely on any teaching in Rettedal to supply.

D. Kunda (Ex. 1007)

73. Kunda is a Japanese patent application publication titled “Folded Loop Antenna.” Petitioners and Professor Young rely on Kunda solely for the limitations related to an “antenna having a pair of electrically conductive loops” in claims 9 and 10. In particular, for Ground 5, they argue that Harvey in combination with Kunda renders obvious claims 9 and 10. As I will explain below, it is my opinion that Kunda in combination with Harvey, does not render obvious claims 9 or 10. *See* Section XIII. The choice of the loop antenna to take advantage of characteristics in antenna detuning and orientation insensitivity in the effective use case of a bolus tag would not have been obvious to a POSA. Antenna choices are particularly critical in wireless devices, as its characteristics may change due to the ambient conductors and dielectric properties, and such changes must be accounted for in the transceiver design. This has been further complicated by the ultra-low-power transceiver designs where the conventional active compensation circuits and adaptive frequency choices may not be feasible due to power considerations. For a bolus tag, the power consumption and the overall device geometry (including antennas) need an integrative consideration for an effective operation over a long span of time.

74. Kunda discloses fitting a loop antenna to two integrated circuits, where impedance matching in the signal chain is critical to avoid antenna reflection and severe self-jamming to the radio frequency integrated chip (“RFIC”). Ex. 1007 at [0024], Fig. 1 (baseband IC 52 and RFIC 54).

Figure 1



75. Ex. 1007 at Fig. 1. Kunda describes a use case of a general communication integrated circuit with a transmitter and receiver in a time-division half duplex, such as for use in mobile phones, where antenna reflection is the key design point. *See id.*; Ex. 1007 at [0001]-[0002], [0024]. Kunda provides no disclosures suggesting that its antenna could be applied in a bolus or other device designed to reside inside an animal body.

VIII. RELEVANT BACKGROUND ON SENSORS, DATA STORAGE, AND DATA TRANSMISSION

A. Sensors

1. General Background on Sensors

76. In general, sensors are components that measure a physical property, such as temperature, and produce an electrical signal corresponding to that property. In ultra-low-power systems such as bolus, a POSA would have been familiar with low-power sensor configurations, including sparse intervals of sensing and transmission, event-driven duty cycle control, power-gated signal generation, and sample-and-hold sensor circuits.

77. Event-driven duty cycle control refers to systems where the sensor or sensing subsystem is activated only when a specific event occurs. For example, in a sensor with an event-driven duty cycle, the sensing element could be activated briefly at each event, then powered down or remain inactive between readings. When it is powered down and inactive, the sensor does not generate a signal. A POSA would understand that in such a configuration, the sensor is not continuously generating a signal—it is producing an output only when actively engaged.

78. Power-gated signal generation describes the use of electronic switches or power domains to selectively provide or cut off power to the sensor. This technique allows for the sensor to remain in an unpowered state between measurements, again ensuring that a continuous signal is not generated. A POSA

would recognize that in such systems, the sensor circuit may physically exist but is not producing any signal while power-gated (i.e., when power is cut off).

79. Each sensor measurement, signal generation and signal transmission represents a use of energy. Without any energy input, any system will go to an equilibrium state as required by the Second Law of Thermodynamics. A system cannot draw energy or signals from a sensor in thermal equilibrium. Drawing information from sensors involves a coupling of readable energy to the target; any signal recognition will involve an applied energy as dictated by the Shannon theory. Therefore, ultra-low power mobile systems need to consider all schemes of sensing, communication and data storage carefully to preserve the limited battery capacity.

80. Sample-and-hold circuits are another technique in which a sensor samples an analog voltage during a narrow time window and then maintains that voltage on a capacitor or storage element. The sensor may then be inactive or powered off, with the stored value used by subsequent circuitry. This also results in non-continuous signal generation.

81. These techniques—such as event-driven sensing, sparse duty cycling, power gating, and sample-and-hold—reflect design practices in the field of embedded sensing, such as in energy-constrained systems like a bolus, where the sensor is not generating a continuous signal.

2. Thermocouples

82. Thermocouples are passive temperature sensors that operate based on the “Seebeck effect,” a thermoelectric phenomenon where a voltage potential is produced between the junction of two dissimilar metals in response to a temperature differential. This voltage is analog, and its value changes depending on temperature. In thermal equilibrium, i.e., a steady state with no energy input, the Seebeck potential will be balanced out by the sheet charge at the metal interface and contacts. However, thermocouples do not generate an output signal unless they are integrated into an electrical circuit. Extraction of the Seebeck potential can be only performed with a test current-voltage response. Without a closed loop to permit current flow, such as a readout interface, the thermocouple only possesses a passive voltage potential across its terminals and does not actively generate a signal to any system component. A POSA would understand that such a voltage does not directly constitute a generated “sensor signal” in practical terms. In bolus systems, for example, thermocouples may be embedded in power-gated, event-driven, or sample-and-hold configurations, where the sensing interface is activated only at intervals, producing non-continuous signal output where the signal does not necessarily vary when the temperature changes. These considerations are entirely consistent with thermocouple physics and ultra-low-power bolus design requirements.

3. *Thermistors*

83. Thermistors are resistive temperature sensors whose resistance changes with temperature. Thermistors are not self-powered. The temperature readout can only be accomplished by a resistance measurement, i.e., an applied voltage or current source to produce a measurable voltage output. In ultra-low-power systems such as boluses, thermistors may be duty-cycled, event-driven, or power-gated, meaning they are only connected to power and readout electronics when a measurement is needed. A POSA would understand that thermistor-based systems can be configured to operate in non-continuous fashion using sample-and-hold architectures, for example, which power on the sensing circuit, capture a reading, and then power off. Therefore, thermistors do not necessarily generate a continuous signal when temperature varies and are compatible with ultra-low-power sensor configurations.

4. *EEG, ECG, and EMG Sensors*

84. Electroencephalogram (EEG), electrocardiogram (ECG), and electromyogram (EMG) sensors are used to measure bioelectric signals from the actuation of brain, heart, and muscles, respectively. These sensors rely on the detection of differential voltage potentials across an animal's skin surface using specially positioned electrodes. A POSA would understand that such sensors require intimate skin contact to designated electrode locations and cannot function properly without this contact. The skin contact can be of solid forms, such as the Ag/AgCl

system in column electrodes in order to avoid a rectifying contact. Alternatively, fluid contacts are possible with saline buckets. In practice, this means a POSA would have understood that these sensors must be affixed to the external or internal body surface, and are not compatible with use in an untethered bolus inside the digestive tract of an animal. For example, the digestive environment prevents accurate acquisition of electrical surface potentials, and these sensor modalities are not suitable for internal or ingestible sensor systems.

B. Analog Data Processing and Storage

1. General Background on Data Processing and Storage

85. Data processing and storage in monitoring systems can be used to preserve measurements for later transmission or analysis. The information representation in the processing and storage systems can be digital or analog. In analog storage, sensor outputs are recorded directly as a real number, such as analog voltages, charges, or magnetic states, without conversion into binary or symbolic formats. In other words, they are not encoded, which refers to the transformation of a signal into a discrete format, such as a digital code. A POSA would understand that encoding is not required when using analog storage, as the original analog data can be processed and stored in its native form. Furthermore, in systems where analog storage is used, encoding can be applied after the data is stored, such as during further processing and transmission. Thus, analog storage is a viable and encoding-

free option in systems designed to monitor certain parameters of a subject, such as physiological parameters of an animal. Specifically, a POSA would have understood that analog memory types, such as those discussed below, could be used to store data in systems such as those described in the Harvey and Risky references, including storing data supplied in a non-continuous fashion by the sensors discussed above in Section VIII.A.1-3.

2. Analog EEPROM

86. Certain types of EEPROM memory are analog, such as those that use Floating Gate MOSFETs as the primary memory element. A floating-gate MOSFET stores analog charge on an isolated gate, thereby altering the transistor's threshold voltage in a continuous manner. A POSA would recognize that when EEPROM cells are operated in the analog forms, they can store analog values instead of discrete digital bits. In other words, EEPROMs can store analog data and function as analog memory. An alternative view can be rationalized by the multi-level EEPROM, where one cell stores more than 1 bit (e.x., 4 bits by $2^4 = 16$ levels). The continuous state of floating-gate charges can be mapped to nearly continuous multiple levels, instead of binary classification. For example, ultra-low-power neuromorphic computing systems can use floating-gate analog memory as analog synapses, mimicking biological neural learning through continuous weight adjustments. In these systems, data is stored as continuous charge levels, and no encoding is

required. A POSA would have understood that when floating gate MOSFETs are the memory element or “building block” of an EEPROM memory, encoding, and the associated analog-to-digital converter (ADC) which consumes significant power, is not required to store sensor data. A POSA would have understood that analog EEPROM could be used to store data in systems such as those described in the Harvey and Risky references, especially when the system power is limited.

3. Capacitive Storage

87. Capacitive storage relies on storing voltage levels across a capacitor. In sample-and-hold circuits, for example, a capacitor is charged to the sensor’s output voltage at the time of sampling and retains this voltage until it is read or overwritten. This is an analog mechanism. A POSA would understand that capacitive storage is common in low-power analog sensor systems and that the stored voltage directly represents the sensed condition. Encoding is not required for capacitive storage to function because the analog signal, such as a charge, is preserved without digital classification. A POSA would understand that capacitive storage could be used to store data in systems such as those described in the Harvey and Risky references.

4. Magnetic Storage

88. Analog magnetic storage operates by storing a signal’s amplitude or variation into the magnetic orientation of a storage medium. While more common in historical contexts (e.g., tape recorders), a POSA would recognize that magnetic

analog storage techniques could be miniaturized used in an animal monitoring system. These systems store signal amplitude directly and do not require digital encoding. A POSA would have understood that magnetic storage could be used to store data in systems such as those described in the Harvey and Risky references.

5. Other Analog Storage Types

89. Other analog memory options include memristors and CCD-based charge storage. Each of these technologies can retain sensor data in a non-digitized format and could be adapted for low-bandwidth, ultra-low-power devices, including an animal monitoring device, as well as in the systems described in the Harvey and Risky references. A POSA would recognize that, for each of these options, the analog signal is stored directly, and no encoding is required.

C. Analog Data Transmission

90. Analog signals, including those generated non-continuously using such devices as those discussed above in Section VIII.A.1-3 and stored in an analog format using the memories described above in Section VIII.B, can be transmitted wirelessly using modulation techniques that preserve the analog signal. Examples include amplitude modulation (AM), frequency modulation (FM), and phase modulation (PM). These techniques were used historically in radio, telemetry, and biomedical applications. A POSA would recognize that analog transmission can be implemented in systems such as those described in Harvey and Risky to send

unencoded sensor data to an external receiver. Such transmission protocols do not require analog-to-digital conversion or encoding.

91. Notably, even if digital *transmission* is ultimately used, analog data can be stored in its native form and converted and encoded only at the transmission stage. Thus, analog storage is compatible with digital transmission systems, and the presence of digital transmission does not require *storing* encoded data.

D. Analog Storage and Transmission in Animal Monitoring Systems

92. In general, digital data storage and transmission is not necessary for storing and transmitting radio signals. In the context of monitoring physiological parameters of an animal, including before and at the time of the invention for the '644 Patent, analog storage and transmission techniques would have been viable options for storing and transmitting data, such as by using the techniques discussed above in Section VIII.B-C. By extension, a POSA would not have considered digital data storage or transmission, or encoding of analog signals, to be required or necessarily present in animal monitoring systems. Specifically, the analog storage and transmission technologies discussed above—which do not require encoding of analog data acquired by sensors—would have been considered possible in the systems described in the Harvey and Risky references, especially when ultra-low power consumption is one of the most important system requirements.

IX. GROUND 1: CLAIMS 5 AND 6 ARE NOT ANTICIPATED BY HARVEY

93. In my opinion, Harvey does not anticipate claims 5 and 6 of the '644 Patent.

A. Elements 5[A] and 5[E]: “generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal” and “enabling a radio signal generator located within said bolus”

94. With respect to claim element 5[A], Petitioners and Professor Young do not establish that Harvey expressly discloses “generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal.” Ex. 1001 at claim 5. Specifically, they do not show that Harvey discloses “one or more sensors contained in a bolus.” Additionally, with respect to claim element 5[E], Petitioners and Professor Young do not establish that Harvey expressly discloses “enabling a radio signal generator located within said bolus.” Ex. 1001 at claim 5. Specifically, they do not show that Harvey discloses “a radio signal generator located within said bolus.”

95. The '644 Patent explains that the claimed “bolus” is an internal device that “reside[s] in the reticulorumen of a ruminant animal”—as opposed to an external device, such as an ear tag. Ex. 1001 at Abstract, 1:5-7 (“An animal monitoring device configured as a bolus for oral administration to reside in the reticulorumen of a ruminant animal.”); *see also id.* at 1:18-30 (“...orally administered to reside in the

reticulorumen for monitoring of physiological parameters of ruminant animals...”), 3:36-38 (“[T]he term ‘reticulorumen (5)’ means the first chamber in the alimentary canal of a ruminant animal (3) composed of the rumen and reticulum.”), 7:44-46 (“[T]he power source (46) of a bolus (1) disposed in the reticulorumen (5) of the ruminant animal (3) cannot be recharged.”), 7:56-65 (“...operational within the reticulorumen (5) of the ruminant animal (3) for greater than three years and up to about ten years...”), 13:14-24. As I noted above in Section VII.B, Petitioners and Professor Young rely on a limited discussion of a speculated bolus “implementation” in Harvey and impute that discussion onto Harvey’s different transponder embodiments. In doing so, Petitioners and Professor Young further assert that “Harvey’s cattle bolus” includes the recited elements. *See, e.g.*, Pet. at 18-19, 23-25; Ex. 1002 at ¶¶ 58, 67, 70. Harvey never discloses a design where the sensors or radio signal generators in its transponder embodiments are contained in a bolus that resides inside the reticulum of a ruminant animals, or that Harvey’s transponder would even be suitable in a bolus. Further, a POSA would not understand Harvey to be making such a disclosure, as I will further discuss below.

96. In summary, the claimed bolus must contain both a “sensor” (as required by element 5[A]) and a “radio signal generator” (as required by element 5[BE]). For those separate requirements, Professor Young and Petitioners cite a specific “intelligent active tag” or “IAT” in Harvey. *See, e.g.*, Ex. 1002 at ¶ 56 (citing

Ex. 1004 at 11:10-14 (“In yet other non-limiting implementations, IAT 1110 may be restrained or moveable within monitored subject 1010, for example, as a digestive tract bolus device, or as a miniature transponder lodged or secured within the circulatory system, bone, or soft tissue. In ruminant monitored subjects such as cattle, a digestive tract bolus tag may be retained indefinitely within the animal.”). In other words, according to Harvey, the IAT embodiment that Professor Young and Petitioners rely on “may be...a digestive tract bolus device.” *Id.* But Harvey never describes that IAT embodiment as containing a “sensor” or “radio signal generator” as required by the claims. Because of that, for those additional two requirements, Professor Young and Petitioners rely on a separate “intelligent transponder” embodiment known as “XPDR 5000.” See Ex. 1002 at ¶ 57 (relying on XPDR 5000, i.e., Harvey Figure 5, for the claimed “sensor”); ¶¶ 67-69 (relying on Harvey Figure 5, which is the XPDR 5000 embodiment, for the claimed “radio signal generator”). Professor Young and Petitioners do not connect these separate teachings of a “bolus” and “XPDR 5000,” and they also do not provide any evidence that a POSA would interpret Harvey to teach a single device, system, or method that includes both features. A POSA would therefore not interpret Harvey as disclosing a single device, system or method, that includes or uses a bolus that contains both a sensor and radio signal generator as required by the claims.

1. Harvey's Limited Discussions of a "Bolus"

97. Petitioners and Professor Young rely on Harvey's single, conclusory reference to a "bolus" and assume that it applies to all other embodiments, examples, and implementations in Harvey. Other than that single mention, Harvey does not reference or describe a "bolus" in connection with any embodiment or component. Instead, Harvey focuses on an implementation of an "ear tag" attached to the ear of an animal, which has different design requirements than a bolus. For example, an internal bolus and external ear tag require different antennae, batteries, and communication protocols. In relying on separate "bolus" and "ear tag" embodiments for different claim requirements, Professor Young and Petitioners mix and match different teachings in Harvey and refer to them as teaching "Harvey's cattle bolus." Petitioners and Professor Young do not provide a reason to combine those different teachings, or explain why a POSA would have understood the various embodiments to be connected in a single device, system, or method, including in the manner taught and claimed in the '644 Patent.

98. As I discussed above, Harvey describes a "subject management system" using an "IAT" and "interrogator." See Section VII.B. In addressing potential IAT "implementations," Harvey states that "an active tag" may be secured to an animal "as a collar, bracelet, ring, or apparel, or as an ear tag, tail tag, or piercing stud," or "may be restrained or moveable within monitored subject 1010,

for example, as a digestive tract bolus device, or as a miniature transponder lodged or secured within the circulatory system, bone, or soft tissue.” Ex. 1004 at 11:9-13. Following that limited discussion, Harvey never again mentions or describes a “bolus” in connection with any of its different embodiments and components. Harvey’s descriptions of its management system, the IATs, and other components, are focused solely on an implementation of an “ear tag” attached to the ear of cattle. See, e.g., Ex. 1004 at 11:4-14, 22:29-30, Figs. 1-4; see Section VII.B. A POSA would not have understood Harvey’s other embodiments or components to apply to a bolus implementation, but instead would have understood them to be for an external ear tag, which I will further explain below.

2. Harvey Does Not Describe a Sensor or a Radio Signal Generator Contained in a Bolus

99. For elements 5[A] and 5[E], Petitioners and Professor Young assert that “Harvey’s bolus includes a transponder containing multiple sensors, as illustrated in Fig. 5,” and the “transponder within Harvey’s cattle bolus includes RF module 5400 which includes RF transceivers 5410 and 5411, depicted in Fig. 5.” Pet. at 18-19, 23-25; Ex. 1002 at ¶¶ 58, 67. Petitioners and Professor Young do not identify a disclosure in Harvey expressly stating that the transponder (i.e., XPDR 5000), the sensors (i.e., Sensor #1 5310 and Sensor #2 5320), the RF module (i.e., RF Module 5400), or the RF transceivers (i.e., XCVR #1 5410 and XCVR #2 5411) in Figure 5 are contained or would be capable of being contained in a bolus implementation.

Instead, as I discussed above, Petitioners and Professor Young apply a single reference to a potential “bolus” implementation of an IAT to other embodiments of a transponder in Figure 5 that involves an ear tag in its design considerations. See Section VII.B. Petitioners and Professor Young do not explain how those embodiments are related to each other or explain why a POSA would understand that an internal bolus could be used for all embodiments and applications in the reference. Petitioners and Professor Young also do not assert that the components are inherently contained in a bolus or assert that a POSA would have understood Harvey to be teaching these components to be included in a bolus implementation. Due to the design considerations of antenna detuning and extremely limited power supply, for example, Harvey’s teaching would not have been a suitable design to enable the bolus communication and sensing functions over a span of more than 5 years.

100. Specifically regarding element 5[A], which requires “one or more sensors contained in a bolus,” Professor Young and Petitioners rely on the “IAT” embodiment described above (that “may” include a “bolus”) in combination with the separate “transponder” embodiment known as XPDR 5000. For the alleged “bolus,” Professor Young and Petitioners cite to Harvey’s statement regarding one “IAT” embodiment that “may be ... a digestive tract bolus device.” See Ex. 1002 at ¶ 56 (citing Ex. 1004 at 11:10-14). For the alleged “sensor,” Professor Young and

Petitioners further rely on the “XPDR 5000” embodiment depicted in Figure 5. *See* Ex. 1002 at ¶¶ 57-58 (citing Figure 5 and related text in Harvey). Professor Young and Petitioners do not address whether those embodiments are connected to one another (which, in my opinion, they are not). Professor Young, for example, asserts that “a POSA would understand that that the sensors *in Harvey’s orally administered bolus* generate sensor signals” without addressing that those cited sensors relate to an ear tag embodiment. Ex. 1002 at ¶ 58. Petitioners assert that “*Harvey’s bolus* includes a transponder containing multiple sensors, as illustrated in Fig. 5,” but they do not cite to Professor Young to support that assertion. *See* Pet. at 18 (emphasis added). Instead of applying any sensors to Harvey’s bolus, Professor Young asserts that “[t]he *transponder* disclosed in Harvey has multiple sensors, as illustrated, e.g., in Fig. 5” without explaining why the “transponder” (i.e., XPDR 5000) would be contained within Harvey’s bolus. *See* Ex. 1002 at ¶ 57 (emphases added).

101. Professor Young and Petitioners also rely on the separate teachings of a “bolus” and XPDR 5000 in Harvey for the “radio signal generator” requirement in element 5[E], without arguing that the two embodiments would be connected or combined and without explaining why a POSA would interpret the embodiments as connected. Specifically, Professor Young states that “[t]he transponder within Harvey’s cattle bolus includes RF module 5400 which includes one or more RF transceivers 5410 and 5411” is “depicted in Fig. 5,” i.e., the XPDR 5000

embodiment. Ex. 1002 at ¶ 67; *see also id.* at ¶ 68. He further states that “[e]ach RF transceiver generates radio signals and thus is a radio signal generator, as is the entire RF module.” *Id.* at ¶ 69. However, he does not cite any evidence or provide any explanation that would support that XPDR 5000 or any of the cited “RF transceivers” would be understood to be part of Harvey’s “bolus” embodiment.

102. Therefore, Professor Young and Petitioners do not establish that Harvey discloses the claimed bolus without need for combining various disclosures not directly related to each other by the teachings of Harvey, and they do not explain how or why Harvey’s various disclosures or embodiments would be combined. Specifically, Professor Young and Petitioners do not acknowledge that Harvey’s digestive tract bolus device and XPDR 5000 are separate embodiments, and they do not connect the two embodiments together. They therefore do not identify any device, system, or method in Harvey that “generat[es] a sensor signal from one or more sensors ***contained in a bolus***” or “enable[es] a radio signal generator ***located within said bolus***” as required by the claims.

103. A POSA reading Harvey’s description of the transponder depicted in Figure 5 would not have understood the bolus and XPDR 5000 embodiment to be connected or capable of being combined. For the XPDR 5000 embodiment, a POSA would have understood Harvey to be describing an “ear tag” device whose components are not suitable for a bolus or part of any bolus. For example, an internal

bolus and external ear tag require very different antennae, batteries, and communication protocols. This is consistent with Harvey's explicit teachings of XPDR 5000 as being part of an ear tag and not a bolus. Harvey introduces the XPDR 5000 embodiment as "a constituent element of multi-modal intelligent active tag 2000" that can be "coupled to monitored subject 5800, for example, by intimate affixment, as described relative to FIG. 3." Ex. 1004 at 22:30-33. Figures 3A and 3B of Harvey illustrate "tag 2000" as an "intimate affixment to a surface of cattle ear 3000." Ex. 1004 at 19:13-14. A POSA would have understood Harvey to clarify that the XPDR 5000 is not used in a bolus configuration by expressing the benefits of affixing the tag *externally*, as shown in Fig. 3A, which depicts an ear:

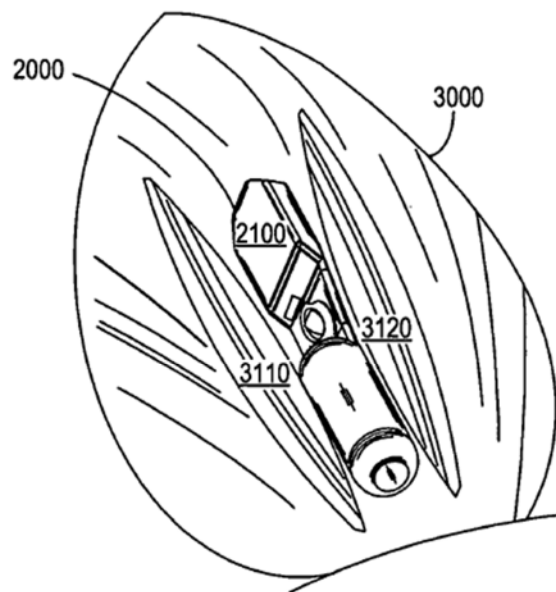
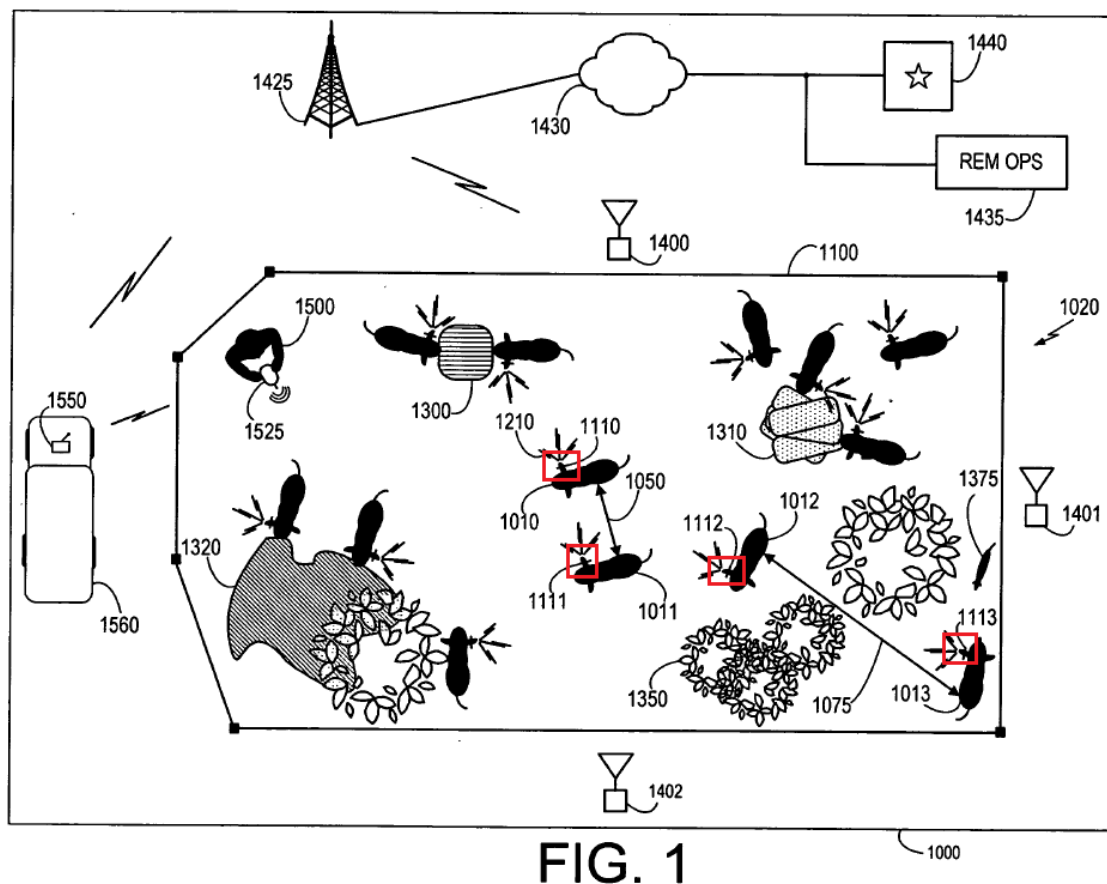


FIG. 3A

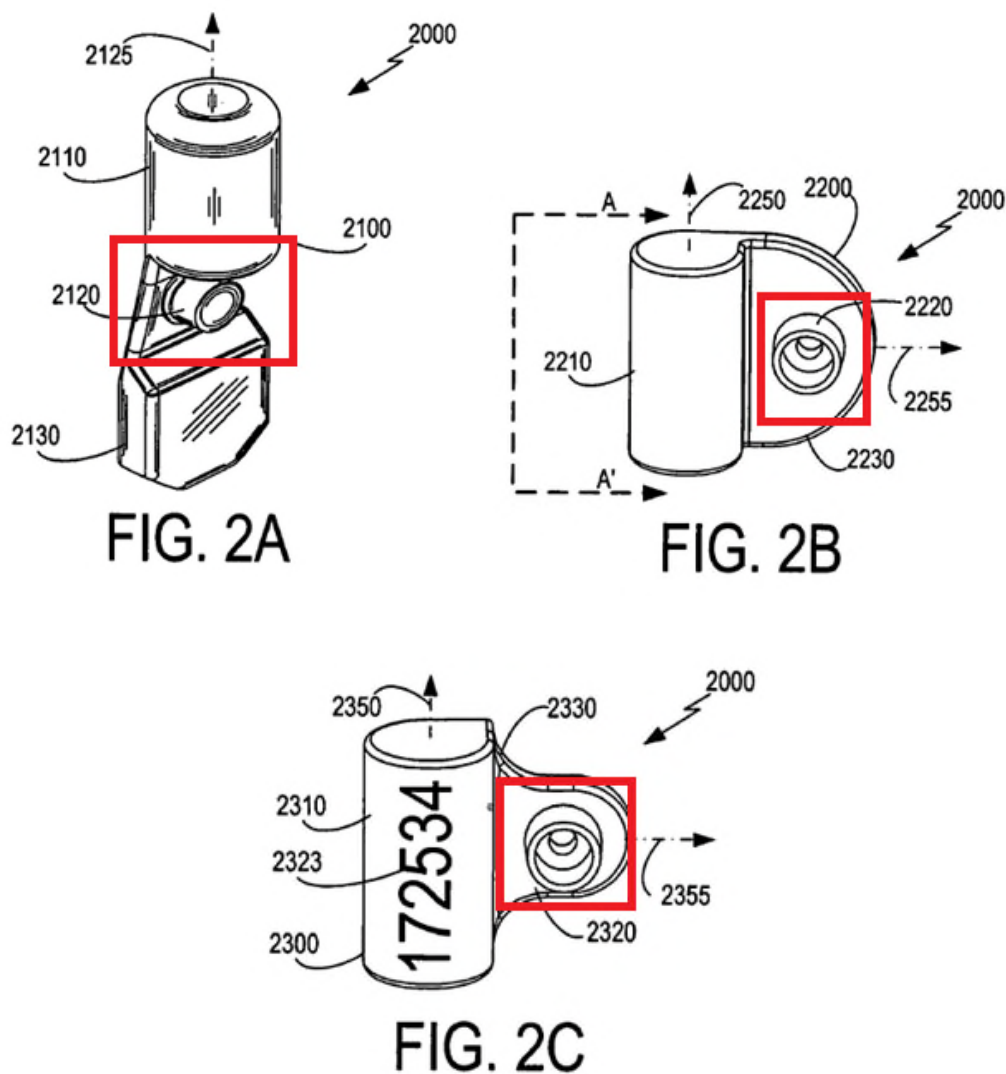
Ex. 1004 at Fig. 3A, 8:19-20, 19:16-17. Harvey further explains that the tag placement should be in “a region affording visibility of the tag while avoiding permanent physical injury to the subject.” Ex. 1004 at 19:19-21. For example, a POSA would understand that an internal bolus would not “afford visibility” because it is located within the reticulum of the animal. See Ex. 1001 at Abstract, 1:5-7.

104. The remaining figures and descriptions in Harvey also illustrate that the XPDR 5000 embodiment that Professor Young and Petitioners rely on is an external tag, not a bolus. Figure 1 of Harvey, for example, depicts all tags as affixed to the ears of cattle (*e.g.*, components 1010-1113 in the figure):



Ex. 1004 at Fig. 1 (annotated).

105. Figures 2A, 2B, and 2C of Harvey illustrate three possible “form factors” of ear tags, each including an “affixment fitting” so the tag “may be affixed to the ear of monitored subject” (i.e., affixed to the ear of an animal):



Ex. 1004 at Figs. 2A-2C (annotated), 17:29-30; *see also id.* at 17:31-33, 18:3-17.

106. A POSA also would have understood Harvey’s XPDR 5000 to be part of an external device only and unsuitable for an internal bolus based on the sensors

disclosed as part of the tag. *See e.g.*, Ex. 1004 at 6:11-12, 8:5-7, 11:8-10, Figs. 1-3B. For example, Harvey explains that the XPDR 5000 can include “a biopotential sensor for identifying electrophysiological events including one or more of EEG (electroencephalogram), ECG (electrocardiogram), and EMG (electromyogram) waves.” Ex. 1004 at 41:1-6. A POSA would have understood these sensors as described in Harvey to be used to measure physiological parameters from intimate affixment to the *exterior* surface of an animal and that they are not feasible or practical in a bolus that resides freely *inside* the reticulum of an animal. *See* Section VIII.A.4 above. That is, a POSA would have understood that each of these types of sensors require intimate contact to the designated skin electrodes, not in the environment of the digestive tract. *See id.* This is not possible or practical in a bolus residing inside the animal’s reticulum, and thus a POSA would not understand the XPDR 5000 to be suitable for a bolus. In other words, by explaining that XPDR 5000 includes sensors that are unsuitable for a bolus, a POSA would have understood that XPDR 5000 relates to external devices, such as an ear tag, and is disconnected from (and not combinable with) any separate discussions of a “bolus” configuration in Harvey.

107. Additionally, Harvey discloses that the sensors in XPDR 5000 may also sense a “vocalized sound” or an “ambient sound,” indicating that the sensors in this transponder are being used in a device attached the outside of the animal’s body. Ex.

1004 at 40:19-20. A POSA would therefore have understood that Harvey’s sensors are contained in a device affixed to the exterior of an animal, such as an ear tag.

108. In summary, I do not see evidence that Harvey discloses “one or more sensors contained in a bolus orally administered to said ruminant animal” or “a radio signal generator located within said bolus.” It is therefore my opinion that Harvey does not anticipate claims the challenged claims, and Ground 1 does not show the challenged claims to be unpatentable.

B. Element 5[C]: “encoding said sensor signal from said one or more sensors as encoded physiological data corresponding to said one or more physiological parameters of said ruminant animal”

109. Petitioners and Professor Young do not show that Harvey discloses “encoding said sensor signal from said one or more sensors as encoded physiological data corresponding to said one or more physiological parameters of said ruminant animal,” as required by element 5[C].

110. Harvey does not expressly teach encoding sensors signals into encoded physiological data. I reviewed Harvey in its entirety and did not see any reference to or description of encoding sensor signals or converting analog sensor signal into digital data. The descriptions of sensor signals, how they are stored and transmitted in Harvey are generic, the format of the data (e.g., analog or digital), or whether they are ever “encoded” is not specified. For example, Figure 5 of Harvey depicts a “Sensor Module 5300” that contains multiple sensors (“#1,” “#2,” “#N”):

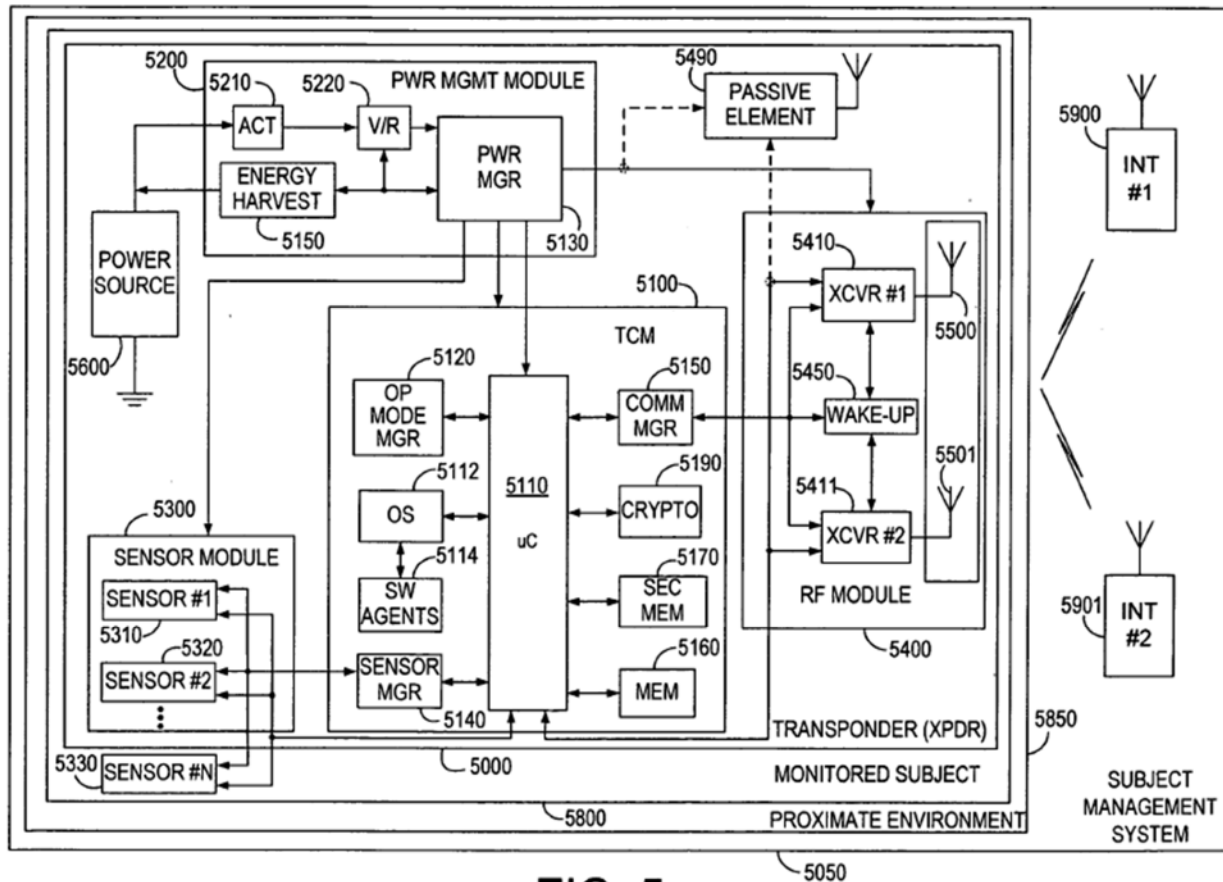


FIG. 5

But Figure 5 and its descriptions do not depict or describe, for example, an analog-to-digital converter that could convert or encode analog data from those sensors into a digital format. The sensors in Sensor Module 5300 are shown to be connected to a “Sensor Manager 5140” via a microcontroller “uC 5110” that is part of a control module “5100.” That microcontroller is connected to several components that perform various functions, such as memory (5160), but there is again no explicit teaching that the data from the signal from the sensor is encoded anywhere in the Figure 5 embodiment.

111. Professor Young does not identify any explicit teaching of “encoding said sensor signal from said one or more sensors as encoded physiological data corresponding to said one or more physiological parameters of said ruminant animal” in Harvey. Instead, he argues that the alleged sensors in Harvey produce signals in “analog form” and that “Fig. 5 discloses a transponder control module (5100) comprising a microprocessor (5110), MEM (5160), SECMEM (5170), operational system code (5112), and application program code (5114)” and based on that “[t]he specification implicitly discloses that said sensor signal from said one or more sensors are digital representation of an analog signal produced by the said sensor.” Ex. 1002 at ¶ 61. I disagree that the sensor signals in Harvey are necessarily a “digital representation of an analog signal” because the sensor signals can remain in analog form in the components in Figure 5 depicted by Harvey, as discussed further below.

112. Professor Young further argues that analog measurements from Harvey’s sensors are necessarily encoded into a digital form because they are “(1) sent into the transponder’s microcontroller 5110, which is a digital device and thus processes incoming information digitally (*see* Ex. 1004 at 29:21-28, 39:4-5 (uC receives sensed data from sensors), Fig. 5), (2) stored in the transponder’s memory, *see infra* Element 5[D], and (3) transmitted wirelessly using one or more digital protocols such as, *e.g.*, Bluetooth, Zigbee, IEEE 802.15.1, IEEE 802.15.3, IEEE

802.15.4, IEEE 802.15.4a, WiFi, IEEE 802.11 (including IEEE 802.11a, 802.11b, 802.11g, and/or 802.11n), 802.16b, 3G, or 4G (see Ex. 1004 at 10:3-11:3, 24:20-23, 42:36-43:20).” Ex. 1002 at ¶ 62.

113. First, a POSA would have understood that Harvey’s microcontroller (5110) does not necessarily process incoming physiological information “digitally” as Professor Young argues. Many microprocessors have reserved one or two analog I/O ports for sensor integration, and Harvey’s microcontroller does not imply or require digitization. Harvey states only that uC 5110 “can operate in accordance with executable instructions” and may cooperate with “system code (OS) 5112” or program code agents 5114,” which may be “suitable and sufficient operating instructions incorporated in firmware.” Ex. 1004 at 29:21-28. But nowhere does Harvey state that uC 5110 digitizes or encodes sensor signals, nor does it have to. Microcontrollers can operate in mixed-signal environments, and POSAs would have known that analog microcontrollers exist, such as those that directly receive and process analog voltage inputs—e.g., voltage or resistance measurements—without converting those signals into digital form (e.g., to save power consumption). In other words, while the microcontroller may execute instructions, it can operate on analog I/O data using analog control circuitry or signal conditioning blocks. For example, analog microcontrollers using analog computing blocks, op-amps, filters, or comparator-based logic can execute control functions or decision logic without

converting inputs into digital form. Harvey does not describe any analog-to-digital converter (ADC) or other encoding circuitry associated with the microprocessor to suggest that encoding is necessarily present due to Harvey's microcontroller. Furthermore, Harvey discusses at a high level that "Sensor 5140" may "cause one or more of sensor #1 5310, sensor #2 5320, or sensor #N 5330 to sense" and provide data "to uC 5110." Ex. 1004 at 39:3-4. A POSA would understand that this high-level control logic does not address whether the data is analog or digital and does not disclose any analog-to-digital conversion.

114. Second, a POSA would not have understood that Harvey necessarily encoded physiological data merely because data is "stored in the transponder's memory," including based on the specific "memory" components of Harvey that Professor Young relies on for Element 5[D]. For that element, Professor Young relies on "memory 5160" and "SECMEM 5170" in Figure 5. Ex. 1002 at ¶ 64. But neither "memory 5160" nor "SECMEM 5170" is limited to digital data. A POSA would understand that those components could store data without encoding it, such as by using an analog storage technique. See Section VII.B above.

115. Harvey states that MEM 5160 may include volatile or non-volatile memory, "including EEPROM or NVRAM, or both." As discussed above, for example, EEPROM can store analog data and would not require encoding. See Section VII.B above. Additionally, Harvey is not limited to digital EEPROM. Other

forms of analog memory exist—for example, floating-gate MOSFET arrays that store variable charge levels as physical quantities—and could be used in conjunction with uC 5110. Many of such examples exist in synaptic or neuromorphic computing. *See* Section VII.B above. Thus, encoded digital data is not required by or necessarily present in memory 5160 or SECMEM 5170 in Harvey.

116. Regarding memory 5160, Harvey describes it generically as “a memory element” and states that it “may include volatile memory, including RAM, non-volatile memory, including EEPROM or NVRAM, or both.” Ex. 1004 at 29:17-24. There is no requirement here for digital formatting. For instance, analog EEPROMs exist and can store analog information as continuous charge levels, allowing physiological measurements to be recorded directly without digitizing or encoding. *See* Section VIII.B.2 above; *see also* Sections VIII.B.3-5, VIII.D. Harvey’s broad terminology leaves room for this type of analog memory implementation, which does not require encoding. Therefore, encoding is not necessarily present in Harvey based on its discussion of memory 5160.

117. Similarly, Harvey’s secure memory 5170 (SECMEM) does not necessarily store encoded data. The fact that Harvey refers to it as “computer-readable media” does not necessitate encoding or digitization of physiological data. Harvey merely states that SECMEM 5170 may be used to “secure[ly] store sensitive information,” such as a PKI key pair, and that access “may be limited to access by

TCM 5100” to prevent malicious tampering. *See* Ex. 1004 at 30:6-9. None of this speaks to the format of physiological data stored, it only suggests that the memory may be secure. Even if the memory is secure and non-volatile, a POSA would understand that it could still hold unencoded analog data, including any alleged physiological data, such as voltages and other analog waveforms. *See* Sections VIII.B, VIII.D above.

118. Professor Young and Petitioners also rely on generic language stating that “subject data” or “subject dynamic information” is stored, which a POSA would understand is not limited to digital or encoded data. *See* Ex. 1004 at 11:20-24, 14:1-3; *see also id.* at 33:32-34:5 (referring to “monitored subject-related data,” and “subject state alert”). Harvey never explains how these values are formatted or whether any encoding takes place. A POSA would understand that such data could refer to analog data (e.g., voltage levels from temperature sensors) that is not encoded.

119. Harvey’s descriptions of storage operations also do not necessarily require encoded physiological data. For instance, Professor Young and Petitioners cite Harvey’s statement that “pulled data may be buffered in MEM 5160, SECMEM 5170, or both,” and may include “a selected sensed physical quantity representation generated by SDM 5300.” The “pulled data” is likely a typo of “polled data”, and my comments will follow the logic of “polled data”. *See* Ex. 1004 at 33:32-34:5.

Again, this does not disclose digital data or otherwise require encoding. A “physical quantity representation” could refer to an analog voltage stored in analog EEPROM or capacitor-based memory, for example. *See* Section VIII.B above. A POSA would not have understood these data types to be necessarily digital or encoded.

120. The control sequences cited by Professor Young and Petitioners reinforce that Harvey contemplates storing unencoded sensor output. For example, Harvey describes a process where “sensor manager 5140” causes SDM 5300 to “sense one or more selected sensed physical quantities” and then “transfer the ... physical quantities to MEM 5160.” Ex. 1004 at 34:12-22. If encoding were required, Harvey would need to describe, for example, an intervening digitization or formatting step in that transfer process. But that is not disclosed, described, or suggested by Harvey. Analog-to-digital converter (ADC) often consumes significant power, and is not an element to be ignored or assumed in a system diagram, unless such design freedom is intended to be left to the future use-case design choices. The physical quantity can be simply transferred into memory, which supports a non-digital interpretation by a POSA.

121. Harvey’s method flow diagrams are consistent with storing non-encoded data. For instance, Step S12430 states: “performing ... may include storing ... a selected sensed physical quantity representation in a transponder memory.” Ex. 1004 at 71:17-21. Again, a POSA would understand that no digitization or encoding

is disclosed, described, suggested, or otherwise required. A physical quantity could be stored in analog format, and no ADC is shown or described to imply that a conversion or encoding must take place. *See* Sections VIII.B, VIII.D above.

122. In summary, the fact that Harvey discloses memory elements that may store subject data or sensed physical quantities does not mean those data are encoded or digital. Analog data can be stored in analog memory. Nothing in the cited passages of Harvey—including the language about SECMEM security, subject data, physical quantities, or operating instructions—discloses or necessitates the storage of encoded physiological data.

123. Third, a POSA would not have understood that Harvey teaches transmitting physiological data “wirelessly using one or more digital protocols,” such as the ones cited above by Professor Young. Harvey never states that these protocols are used for transmission of physiological data specifically. *See* Ex. 1004 at 10:3-11:3 (listing “non-limiting examples” of communication protocols without specifying transmitted data types), 24:20-23 (listing “compliant radio air interfaces” without specifying transmitted data types), 42:36-43:20 (listing a “non-limiting example” of a radio configuration and communication protocol without specifying transmitted data types). A POSA would understand that analog protocols exist that could be used to transmit the alleged physiological data without encoding it, such as amplitude modulation (AM), frequency modulation (FM), and other analog modem

(modulation/demodulation) techniques that could be used to transmit sensor voltages without encoding them. See Sections VIII.C-D above. Moreover, Harvey provides no details about how the disclosed examples of protocols interface with the sensor signals or whether analog-to-digital conversion occurs in order for the data to be transmitted.

124. In summary, the alleged analog sensor signals in Harvey are not necessarily encoded into “digital form” because analog data could be stored and transmitted in analog form, such as by using capacitive storage, magnetic storage, and analog EEPROM, and Harvey does not rule out those possibilities. Therefore, Petitioners and Professor Young have not shown that encoding analog data into digital form for storage or transmission is not necessarily present in Harvey.

125. Professor Young and Petitioners further argue that encoding “would occur in an ADC [analog-to-digital converter] within either the sensor module 5300, the sensor manager 5140, or one or more of the sensors themselves.” Ex. 1002 at ¶ 63. However, an ADC is not expressly disclosed or necessarily present in Harvey. I reviewed Harvey in its entirety and did not see a reference to an ADC or any component that could be interpreted as an ADC. Moreover, an ADC is not required or necessarily present in Harvey because the alleged analog physiological data produced by the alleged sensors in Harvey can be stored and transmitted in digital

form. Therefore encoding physiological data into a digital format, including with an ADC, is not required.

126. Professor Young and Petitioners also cite a patent discussing ADC and a dictionary definition of “encode.” See Exs. 1020, 1022. However, I do not see any connection between those references and Harvey. The patent at best explains an example of using an ADC. Ex. 1022 at Fig. 1, 1:31-2:13, 4:22-5:6. And the dictionary at best provides a potential meaning of “encode.” See Ex. 1020 (defining “encode” in the context of “computing” as “to change information into a form that can be processed by a computer”). Neither of these references provides the missing encoding step in Harvey or demonstrate that an ADC or encoding is necessarily present in Harvey because, as explained above, Harvey does not require “encoding” and does not require an ADC as a necessity. Moreover, even if those references somehow provided the claimed encoding step, a POSA would not understand them to be incorporated into or otherwise connected to Harvey.

C. Element 5[D]: “storing said encoded physiological data in a non-transitory computer readable media”

127. Harvey also does not teach “storing said encoded physiological data” as required by element 5[D]. For that element, Professor Young and Petitioners rely on “memory 5160 and secure memory (SECMEM) 5170” illustrated in Figure 5. See Ex. 1002 at ¶¶ 88-90. As explained above, these components do not expressly or inherently store “encoded” physiological data, for example because Harvey does

not rule out the possibility of storing sensor data in a non-encoded form, such as analog. *See* Sections IX.B; *see also* Sections VII.B, VII.D.

128. Moreover, even if I were to assume the alleged physiological data in Harvey were necessarily “encoded” when *transmitted*, Harvey never states that such data was encoded when it was *stored*, which is required by the claim. For example, it is possible for physiological data to be encoded after storage and before or during transmission. *See* Sections VIII.C-D above. Such pre-transmission storage could be in a non-encoded format, such as analog, using the analog memory techniques discussed above. *See* Section IX.A.B above; *see also* Sections VII.B, VII.D.

D. Element 5[F]: “activating said radio signal generator at pre-determined intervals to generate a radio signal to carry said encoded physiological data”

129. Petitioners and Professor Young also do not establish that Harvey discloses “activating said radio signal generator at pre-determined intervals to generate a radio signal to carry said encoded physiological data,” as required by element 5[F]. Claim 5 requires that the radio signal generator be activated to generate a radio signal at “pre-determined intervals,” as opposed to being activated at random times or in response to a triggering event, such as environmental conditions. *See* Ex. 1001 at 1:59-66, claim 5. The ’644 Patent further explains that the “pre-determined intervals” are a set and known period of time, e.g., every twenty-four hours, at which the radio signal generator transmits encoded physiological data.

Ex. 1001 at 10:31-43, 11:16-20 (consistently identifying intervals between transmission as periods of time, such as “twenty four hours,” a certain “time period,” and a “period of time”). This claim element also requires that the specific radio signal that was transmitted at pre-determined intervals must “carry” the “encoded physiological data” of the animal, as opposed to providing mere identification information or pings. Ex. 1004 at 4:39-41, 10:31-43, 11:16-27, claim 5. The external reader needs to be always on to listen to the signals, or maintains accurate synchronization with the bolus sensor to minimize the loss of data packet. Synchronization needs to be maintained over the lifespan of the bolus sensor. As explained further below, Harvey describes numerous transmission operations and embodiments, but it never teaches or suggests to a POSA that one of its embodiments include a radio signal that is both generated at “pre-determined intervals” and also carries “encoded physiological data,” as required by claim 5. Note that these two points are critical elements in power consumption considerations.

130. Petitioners and Professor Young argue that Harvey’s “IAT transponder” (i.e., XPDR 5000) meets the “pre-determined intervals” limitation. I disagree. The teachings that they rely on for this argument refer to separate embodiments that are not connected and that a POSA would not understand to be combinable to achieve the claim limitation. Moreover, as explained further below, a POSA would not

understand that the specific “periodic transmission” that Professor Young and Petitioners rely on would carry “physiological data.”

131. For the “pre-determined intervals” requirement, Petitioners and Professor Young argue that the XPDR 5000 “can transmit outbound messages in a ‘periodic’ manner using a ‘preselected tag transmission interval’ such as every two seconds,” and they cite an example implementation in Harvey where the XPDR 5000 “may initiate communication by transmitting an outbound IAT message to INT 5900 on a preselected tag transmission interval” of “about 2 seconds.” Pet. at 26 (citing Ex. 1004 at 26:6-11); *see* Ex. 1002 at ¶ 72 (citing Ex. 1004 at 26:6-11, 27:14-21, 28:22-27, 32:12-19, 65:32-66:2, 66:19-22, Fig. 9). When reading Harvey as a whole, a POSA would have understood Harvey to explicitly disclose that these specific “transmissions” are part of a “collision avoidance protocol” embodiment. *See* Ex. 1004 at 25:30-26:11. As explained below, a POSA would understand that the periodic transmission is a “ping” to determine if the channel is clear and would understand that such a ping, in the context of Harvey’s teachings, does not carry “encoded physiological data” as required by the claims. *See, e.g.*, Ex. 1004 at 25:2-6 (“A non-limiting example of a selected transmit operation can be a transponder ping operation, in which XPDR 5000 initiates communication by transmitting an outbound IAT message to INT 5900, which may identify XPDR 5000 to INT 5900. An outbound IAT message may be, but is not required to be, a TID or an SID

corresponding to monitored subject 5800.”), 27:6-8. (“In an example implementation of a selected collision avoidance protocol, XPDR 5000 may initiate communication by transmitting an outbound IAT message to INT 5900 on a preselected tag transmission interval.”).

132. For the “carry said encoded physiological data” requirement, Professor Young and Petitioners rely on various descriptions of “IAT messages” in Harvey that allegedly carry “subject data” that are described separately from the “collision avoidance” protocol embodiment. *See, e.g.*, Ex. 1002 at ¶ 71 (citing Ex. 1004 at 14:1-3, 3:18-20, 14:7-9, 15:24-26, 17:18-22, 25:8-11, 33:32-34:5, 65:1-16, 66:3-5, 72:4-73:8, 75:18-22, Fig. 7). None of the various descriptions of “subject data” in Harvey are described as part of Harvey’s “period tag transmission” in its “collision avoidance” embodiment.

133. Therefore, a POSA would have understood that Professor Young and Petitioners are relying on separate embodiments in Harvey for the separate requirements of “activating said radio signal generator at pre-determined intervals” and “carry[ing] said encoded physiological data” at such pre-determined intervals. They do not identify a single device, system, or method that both generates a radio signal at “pre-determined intervals” and also carries “encoded physiological data,” and Harvey does not describe one.

134. A POSA also would not interpret Harvey in a way that connects the various embodiments relied on by Professor Young and Petitioners into a single device, system, or method that includes all of the claimed requirements. Generally, a POSA would not interpret Harvey to connect or teach a combination of its various embodiments. Harvey refers to hundreds of different “embodiments” but never explains that the various embodiments are connected, combined, or combinable, including the various embodiments relied on by Petitioners and Professor Young. Specifically, Harvey does not state that the alleged physiological data (the “subject data” cited by Professor Young in Ex. 1002 at ¶ 71) can be combined with the “periodic tag transmission” in the “collision avoidance” embodiment (cited by Professor Young in Ex. 1002 at ¶ 72). Harvey discusses a “periodic tag transmission interval” only in the context of that “collision avoidance” embodiment where the alleged “periodic” intervals serve a different function (i.e., sending a ping) than transmitting physiological data, as explained further below. Furthermore, Professor Young does not explain why a POSA would understand otherwise. For example, in paragraph 72 of his declaration, Professor Young cites to the passage in Harvey describing the “collision avoidance” embodiment and simply states that an “IAT transponder can transmit outbound IAT messages in a ‘periodic’ manner.” See Ex. 1002 at ¶ 72. But he does not explain why a POSA would understand those messages

to include the alleged physiological data that he describes in paragraph 71 of his declaration. See Ex. 2001 at ¶¶ 71-72.

135. I further analyzed Harvey’s separate discussions of “IAT messages,” “subject data,” and “periodic tag transmission interval” to confirm that the periodic tag transmission would be a ping instead of physiological data. A POSA would have understood that sending physiological data as part of the “periodic tag transmission” would deviate from the purpose of that aspect of Harvey’s “collision avoidance protocol.” As explained further below, in the collision avoidance protocol, the periodic tag transmission would be understood as a ping specifically to “initiate communication” for determining whether the channel is clear. A POSA would understand that any “physiological” information sent as part of that embodiment would only be sent later *if* the ping is acknowledged (i.e., indicating that the signal is clear for sending additional transmission that may include “subject data”). In other words, even if Harvey’s “collision avoidance protocol” were not limited to pings and can transmit physiological data at some point in time, a POSA would understand the specific “period tag transmission” in Harvey to be limited to a ping that excludes physiological data. Any alleged physiological data would be sent in a separate transmission with an unspecified interval. Below I provide additional details on how I was able to confirm this.

136. Harvey's disclosure confirms to a POSA that the periodic transmission in the collision avoidance protocol is referring to a "ping" because pings are used to initiate communication, which is Harvey's stated purpose of the periodic transmission. In Harvey, a "ping" is a specific type of outbound message that may include a "TID" or an "SID," but not encoded physiological data. Ex. 1004 at 14:22-26 ("IAT 1110 may be configured to broadcast a corresponding identifier including, without limitation, a TID or an SID[,], periodically, or aperiodically, and may use a selected collision avoidance protocol."), 12:4-6 ("In general, monitored subject 1010 may be identified by a subject identifier (SID), which may include one or more of a name, an alias, or a identification number, which may be globally-unique or non-globally-unique."), 12:26-27 ("IAT 1110 may have corresponding tag identification (TID) data."). Later, when describing communication operations, Harvey explains the purpose and function of a ping in the XPDR 5000 embodiment that Petitioners rely on:

A selected communication operation may be a selected transmit operation, a selected receive operation, or a selected combination of a transmit operation and a receive operation. A non-limiting example of a selected transmit operation can be ***a transponder ping operation, in which XPDR 5000 initiates communication by transmitting an outbound IAT message to INT 5900***, which may identify XPDR 5000 to INT 5900. An outbound IAT message may be, but is not required to be, a TID or an SID corresponding to monitored subject 5800.

Id. at 25:4-6 (paragraph [0067]) (emphasis added). In other words, a ping is used to initiate communication by transmitting an outbound IAT message to INT 5900. Two paragraphs later, on the next page of Harvey, Harvey expressly states that the specific purpose of the periodic tag transmission is also to “initiate communication by transmitting an outbound IAT message to INT 5900,” which a POSA would thus understand is referring to the above “ping” operation:

In an example implementation of a selected collision avoidance protocol, ***XPDR 5000 may initiate communication by transmitting an outbound IAT message to INT 5900*** on a preselected tag transmission interval, which may be periodic or aperiodic. A selected periodic collision avoidance protocol embodiment may be exemplified by XPDR 5000 periodically transmitting an outbound IAT message to INT 5900, over a selected periodic tag transmission interval of about 2 seconds.

Id. at 26:6-11 (paragraph [0069]). That is, a POSA would understand that the “outbound IAT message” for “initiating communication” in the collision avoidance protocol is a ping because a ping operation is the communication tool expressly taught by Harvey for performing that function. In other words, a POSA would understand that the ping operation of paragraph [0067]—which does not contain physiological data—is used for the “outbound IAT message” in the “selected period tag transmission” in paragraph [0069] of Harvey that Petitioners and Professor Young rely on.

137. Thus, based on Harvey’s description of the cited example “periodic tag transmission” implementation, and Harvey’s preceding discussion of communication operations, the cited example implementation relates to the transponder “ping” messages, and not messages carrying “encoded physiological data” as claimed in the ’644 Patent. As discussed above, paragraph [0067] of Harvey introduces different communication operations and describes a selected transmit operation called a “transponder ping operation,” where XPDR 5000 “*initiates communication* by transmitting an outbound IAT message to INT 5900.” Ex. 1004 at 25:2-4 (emphasis added). Harvey explains that this operation may “identify XPDR 5000 to INT 5900” and may be “a TID or an SID.” Ex. 1004 at 25:4-6. In paragraph [0069], Harvey discusses a scenario where communication contention and collision may occur due to multiple transponders initiating transmit operations to the same interrogator at the same time, and the use of a “selected collision avoidance protocol” to address such scenarios. Ex. 1004 at 25:30-26:6. Harvey then describes an example implementation of this protocol (the example cited in the Petition and by Professor Young) that, similar to the transponder ping operation, has XPDR 5000 “*initiate communication* by transmitting an outbound IAT message to INT 5900” to avoid collision with other transponders. Ex. 1004 at 26:6-8 (emphasis added). Because a ping serves the same stated purpose as the outbound message in the collision avoidance protocol, a POSA would interpret the alleged “outbound

message” sent at “periodic” intervals as a transponder ping, which may include a TID or an SID, but not encoded physiological data. A POSA would further understand that, to the extent XPDR 5000 transmits any alleged physiological data, it would occur only after communication with INT 5900 is established, i.e., only if the interrogator acknowledges one of the pings at an undetermined time.

138. Moreover, it would not make sense to a POSA to interpret the periodic tag transmission in Harvey as configurable to transmit physiological data as opposed to merely a ping. The reason for sending a “ping” in Harvey is to address a scenario where communication contention and collision may occur due to multiple transponders initiating transmit operations to the same interrogator at the same time, which is precisely the purpose of the “periodic tag transmission interval” in Harvey’s “collision avoidance protocol.” Ex. 1004 at 25:2-6, 25:30-26:6, 27:6-8. A POSA would understand that a message containing physiological data would not be used to “initiate communication”—and therefore is not the “outbound IAT message” in the collision avoidance protocol—because the sole purpose of that communication is to confirm whether a channel is clear, not to send animal data. Only if a ping is acknowledged at an undetermined time does Harvey actually transmit additional information about the animal.

139. Additionally, Harvey’s description of a tag transmission interval of “about 2 seconds” teaches a POSA that the transponder is either not transmitting an

outbound message carrying physiological data, as required by element 5[F], or not contained in a bolus orally administered to a ruminant animal, as required by element 5[E]. *See* Section IX.A. A POSA would understand that the purpose of a bolus like the one disclosed in the '644 Patent must remain operational over the entire productive lifespan of the animal, e.g., around 5-6 years for a cow. *See, e.g.*, Ex. 1001 at 7:66-8:3. As the '644 Patent explains, and as a POSA would understand, the majority of power used by the bolus is in the operation of the radio signal generator. Ex. 1001 at 10:37-43. Activating the radio signal generator to transmit sensed data at a rapid two-second rate makes little sense because that operation would use a substantial amount of energy and drain the battery life of the bolus. That would defeat the whole purpose of using a bolus like the invention claimed in the '644 Patent. Instead, a two-second interval is more appropriate for an ear tag, where battery preservation is not as stringent as a bolus tag, e.g., an ear tag that is affixed to the exterior of the cow is more accessible than a bolus, which resides inside the reticulum of the cow. It is also more appropriate for transmissions containing, for example, location data or tracking data, rather than transmissions of physiological data. As a comparison, 2-second intervals are common choices for location information within a cellular network when mobile devices can be in and out a specific cellular area.

140. Petitioners and Professor Young’s reliance on Harvey’s two-second transmission interval also directly contradicts their other positions regarding Harvey’s alleged purpose, and therefore implementing such a transmission interval would render Harvey unfit for its alleged intended purpose. Petitioners and Professor Young recognize that “[t]he ’644 Patent sought to solve the problem of extending the operational life of a bolus having limited battery capacity by regulating energy consumption.” Pet. at 40; Ex. 1002 at ¶ 98. According to Petitioners and Professor Young, “Harvey and Risky both recognized and solved that same problem—extending the operational life of a bolus,” and they described “boluses which save energy by controlling the operation of a radio signal generator that transmits sensor data.” Pet. at 3, 40; Ex. 1002 at ¶ 31, 95; *see also* Pet, 40 (“purpose is to reduce power consumption and prolong battery life”); Ex. 1002 at ¶ 97 (same). If power conservation and extended battery life were truly Harvey’s aims, it makes little sense that Harvey would disclose a configuration that transmits physiological data every two seconds to a receiver, consuming a significant amount of energy in the process. For example, a two-second transmission interval would mean the radio signal generator transmits around 43,200 outbound messages of encoded physiological data per day. That configuration would substantially reduce the battery life and the operational lifespan of the bolus, conflicting with Harvey’s purpose as alleged by Petitioners and Professor Young. It would also be

counterproductive to the power-saving features that they contend Harvey sought to address. In fact, configuring Harvey to transmit physiological data (instead of, e.g., pings) in two-second interval would drain the power source of Harvey too rapidly to be fit for its intended purpose of monitoring an animal over a span of 5 years without battery replacement or recharging inside the animal reticulorumen. Even if the amount of the additional physiological data is small, the sensing evaluation every 2 seconds to feed in such information can also cause significant power consumption. For this reason, among others, a POSA would not interpret the cited two-second transmission intervals to be “pre-determined intervals” for transmitting radio signals that carry encoded physiological data. Note that for the bolus to function over 5 years, ‘644 indicates the pre-determined duty cycling is the design choice, not the more complicated burst or online methods, where the decision to transmit and the collision protocol (such as the Aloha algorithm in incoherent (unsynchronous) network) may suffer additional power consumption. The claimed pre-determined intervals can achieve time-division multiplexing in a power-saving manner.

141. On page 26 of the Petition and in paragraph 72 of Professor Young’s declaration, Petitioners and Professor Young include several different arguments and citations for the “pre-determined intervals” element, but they do not explain how that information shows that Harvey discloses this element. For example, Petitioners and Professor Young make the conclusory assertion that the RF module and RF

transceivers in Figure 5 of Harvey are “necessarily activated at the beginning of each transmission interval in order to transmit the IAT message containing the encoded physiological data.” Pet. at 26; Ex. 1002 at ¶ 72. I understand that for Petitioners and Professor Young to show that is necessarily true, they need to establish that Harvey inherently discloses in the cited example implementation that the RF module and transceivers are activated at each transmission interval to transmit the encoded physiological data. I do not see any evidence cited by Petitioners or Professor Young to support their argument. They also do not explain why a POSA would have understood this element to be inherent in these citations. For example, they do not explain why a POSA would have understood the outbound IAT messages to necessarily include “encoded physiological data” instead of, for example, a ping, a registration message, or identification data. As I explained above, based on the discussion of communication operations in preceding the example implementation relied on by Petitioners and Professor Young, it makes more sense that Harvey is describing a ping operation for initiating communication with the interrogator, and not necessarily sending physiological data. Thus, Petitioners and Professor Young have not established that Harvey discloses the step of “activating said radio signal generator at pre-determined intervals to generate a radio signal to carry said encoded physiological data.”

142. Additionally, Petitioners and Professor Young argue that the “IAT transponder may be assigned its ‘selected tag transmission interval’ during manufacture or by self-assignment.” Pet. at 26 (citing Ex. 1004 at 27:14-21); see Ex. 1002 at ¶ 72 (citing same). That Harvey states different ways to assign a tag transmission interval is immaterial to whether the reference discloses “pre-determined intervals to generate a radio signal to carry said encoded physiological data.” That disclosure provides no additional context or information related to the IAT transponder and the interval itself, such as the type of information being transmitted or the period of time between intervals. Petitioners and Professor Young do not explain how or why it does.

143. The other citations by Petitioners and Professor Young for this element also do not show that element 5[F] is taught by Harvey. Petitioners and Professor Young cite additional portions of Harvey in an attempt to show “pre-determined intervals,” but these purported disclosures do not actually describe transmission intervals, the transmission of encoded physiological data, or even the same embodiments in some instances. For example, Petitioners and Professor Young cite Harvey at 28:22-27, which describes a “predetermined transponder operation” mode. Pet. at 26; Ex. 1002 at ¶ 72. The word “predetermined” in that context is describing the overall “operational mode” of XPDR 5000 itself, and it does not refer to the transmission interval or the transmitter. A transmitter or transmission are not

mentioned at all in that citation. Petitioners and Professor Young also cite Harvey at 65:32-66:2, which describes the transmission of a “REGISTRATION message.” Pet. at 26; Ex. 1002 at ¶ 72. It does not refer to the transmission of any encoded physiological data. That citation also relates to XPDR 7020, which is a different embodiment of a transponder, separate from XPDR 5000 relied on by Petitioners and Professor Young elsewhere. Ex. 1004 at 65:32-66:2. This is another example of Petitioners and Professor Young relying on different embodiments in their attempt to show that Harvey discloses the required elements of the challenged claims.

144. For at least the above reasons, I do not see evidence that Harvey discloses “activating said radio signal generator at pre-determined intervals to generate a radio signal to carry said encoded physiological data.” It is therefore my opinion that Harvey does not anticipate claims 5 and 6, and Ground 1 does not show the challenged claims to be unpatentable.

X. GROUND 2: CLAIMS 5 AND 6 ARE NOT ANTICIPATED BY RISKEY

145. In my opinion, Risky does not anticipate claims 5 and 6 of the ’644 Patent.

A. Element 5[C]: “encoding said sensor signal from said one or more sensors as encoded physiological data corresponding to said one or more physiological parameters of said ruminant animal”

1. Risky’s “Storage in Memory” Does Not Require Encoding a Sensor Signal

146. Professor Young and Petitioners argue that Risky’s sensor signals “necessarily” comprise encoded digital information because they are “stored in the transponder’s memory,” but that is not true. *See* Pet. at 32-33. Sensor signals—such as those from a thermistor or thermocouple discussed in Sections VIII.A.2-3 above—can be stored in a transponder’s memory in non-digital forms, such as analog or raw electrical signals. A POSA would recognize that various types of memory are capable of retaining such non-digital information, such as capacitive storage, magnetic storage, and certain forms of analog EEPROM. EEPROM or floating-gate MOS storing analog weights as an analog synapse is the basic element in ultra-low-power neuromorphic computing systems. *See* Section VIII.B.2 above. Risky does not limit its transponder to any particular type of storage and does not rule out the possibility of storing sensor information in non-digital form. *See, e.g.*, Ex. 1005 at [0041] (referring to “memory unit 250” without specifying a type of storage), [0043] (same), [0044] (same), [0049] (same). Professor Young and Petitioners’ premise that sensor signals are *necessarily* encoded because they are stored digitally is therefore flawed.

147. As alleged support for its flawed premise, Professor Young and Petitioners cite to their discussions of element 5[D], which requires “storing said encoded physiological data.” However, that discussion fails to show that the stored sensor data is necessarily digital. Specifically, they rely on Risky’s depiction of a “memory unit 250” in Figure 2, which they argue “can comprise an Electrically Erasable Programmable Read-Only Memory (‘EEPROM’).” *See, e.g.*, Pet. at 34 (citing Ex. 1005 at [0043]-[0044], [0049], [0052]). But Figure 2 does not limit “memory unit 250” to any particular type of storage. For example, Figure 2 depicts “Read Only 254” as a distinct component within “Memory Unit 250,” which is not limited to a type of storage). *See also* Ex. 1005 at [0004], [0028], [0058] (discussing Fig. 2 without specifying memory type). Risky’s text also fails to teach or suggest that sensed physiological data is stored in EEPROM or in any other type of memory. Rather, a POSA would understand that Risky’s brief discussion of read-only memory, such as EEPROM, is narrowly limited to a specific embodiment in which “UBID” is stored in “read-only storage 254” for a specific purpose. A POSA would understand from Risky’s teachings that UBID is not sensor signals corresponding to physiological data. Ex. 1005 at [0052] (defining “UBID” as “a unique bolus identifier value”). As Risky explains, “[i]n *one embodiment*, the bolus memory unit 250 may comprise read-only storage 254.” *Id.* (emphasis added). “*In this embodiment*, a unique bolus identifier value (UBID) may be stored within the read-

only storage” specifically to “provide a tamper-proof identifier to uniquely identify a particular bolus.” *Id.* Thus, even if UBID is a digital identifier, it is not the sensed physiological data required to be encoded in claim 5, and a POSA would understand that Risky does not require such data to be stored in EEPROM or any specific type of memory.

148. In short, digital storage of sensor signals is not necessarily present in Risky, especially when ultra-low-power consumption is considered as analog-to-digital conversion consumes significant energy when the sampling rate is high. Therefore, storing sensed physiological data in unspecified “memory unit 250” cannot prove that sensor signals are inherently “encoded.” Professor Young and Petitioners therefore do not establish that Risky anticipates claim 5 or 6.

2. Risky’s “Data Structure” Does Not Require Encoding a Sensor Signal

149. Professor Young and Petitioners also argue that Risky inherently discloses digital encoding because sensor readings are allegedly organized into a so-called “Animal Information Data Structure,” but they do not cite any support for this proposition. *See, e.g.,* Pet. at 32. The physiological data in Risky’s “data structures” are *not* necessarily digital or encoded. I further note that the terms “digital,” “encode,” or “encoding” are never mentioned in Risky. In fact, Risky expressly states that “[o]ne skilled in the art would recognize that the animal information data structure 310 of this disclosure should be stored and/or managed

using any data storage and/or management technique known in the art” and that “this disclosure should not be read as limited to any particular data storage and/or management technique.” Thus, a POSA would understand that sensor data can be stored, for example, in analog form—such as by using the techniques explained above in Sections VIII.B and X.A.1—and incorporated into Risky’s “data structure” without necessitating digital conversion. *See also* Section VIII.D above.

3. Risky’s Data “Transmission” Does Not Require Encoding a Sensor Signal

150. Petitioners and Professor Young also argue that Risky’s transponder necessarily transmits digital data because it communicates wirelessly using a “digital protocol.” However, a POSA would not interpret anything in Risky to require that the transmitted sensor signals must be in digital form. First of all, I reviewed Risky in its entirety, and Risky does not use the term “digital protocol” or describe any examples of a digital protocol. Moreover, the mere fact that a system transmits data wirelessly does not establish that the data itself has been converted from analog to digital before transmission. As discussed below, it is possible that, in Risky, the sensor data remains in an analog format even during transmission, and therefore digital encoding is not inherent to Risky based on its discussion of “transmission.”

151. Petitioners and Professor Young cite several discussions of “transmission” in Risky, but none of them teach or suggest that the signals transmitted by the bolus must be digital rather than analog. For example, the

Abstract of Risky describes a bolus that “may comprise a data transmitter in wireless communication with a base station,” with not suggestion that the “wireless communication” must be digital. Ex. 1005 at Abstract. Non-digital information, such as analog signals, can be transmitted and received wirelessly, and Risky does not rule out such an implementation. Similarly, Figure 2 of Risky depicts a “communications unit 230” that includes an “active data transmitter 232” and a “data receiver 234.” However, these are generic components and do not inherently require digital transmission. Ex. 1005 at Fig. 2; *see also id.* at [0037] (describing “transmitter antenna 233” and “receiver antenna 235” without specifying a digital format).

152. A POSA would not understand any of the textual descriptions of Risky’s transmission methods to establish inherent digitization. Digitization consumes significant power, and a POSA would expect it to be explicitly described in the system diagram and signal chains if it is required. Paragraphs 21 and 23, for example, state that a base station may receive messages from the bolus using “a transmitter,” but Risky does not define these messages as digital rather than analog. Petitioners and Professor Young also cite Risky’s discussion of “polling sensors” used in conjunction with a wireless transmitter, but polling sets a sampling frequency, but does not require that the sensor data be digitized or encoded before transmission. For example, Risky states that “processor 240 may transmit sensor

measurements obtained by polling sensors 220 via data transmitter 232.” Ex. 1005 at [0049]. But Risky’s reference to “polling” simply refers to retrieving data from a sensor, which can occur in either analog or digital form. In other words, the “polled” sensor measurements—such as temperature, pH, or movement data—can be transmitted as analog waveforms without digital encoding. In short, petitioner’s inherency argument assumes that because the bolus transmits information, it must first encode the data into a digital format. But that is not true. Transmission alone does not necessitate digitization. Digital transmission with embedded ID and error correction code may be possible, but it is not a required method, especially when the system power is constrained, such as in the case of long-term operation of a bolus sensor.

153. Risky’s references to “media access control” and “unique animal identifier” cited by Petitioners and Professor Young also do not require digitization or encoding of sensor data. In paragraph 50, Risky discusses messages transmitted via data “transmitter 232” that “may comprise a media access control (MAC) value,” but the presence of a MAC address—even if it were digital—does not mean that the *entire* transmitted signal is digital. Ex. 1005 at [0050]. A MAC address is merely an identifier used in networking—it does not dictate the format of sensor data itself. In the example where a MAC address is digital and other data is analog, which is possible in Risky, this is understood as “mixed signals,” i.e., when the system

contains both the digital and analog information at any system module. That is, even a system that transmits a digital MAC address could transmit the sensor signal in analog form. Likewise, Risky's reference to "a unique animal identifier (UAID)" that "may be transmitted with some or all of the messages originating from a particular bolus" does not necessitate encoding the sensor signals. Ex. 1005 at [0051]. The inclusion of digital identifiers that may be digital (like a UAID or MAC) does not require that *all* transmitted data, including sensor data, necessarily must be digital. These identifiers serve only to associate a bolus with an animal. A POSA would understand that they do not inherently require sensor data to be digitized.

154. Petitioners and Professor Young also cite paragraph 58 in Risky, which merely describes power sources for the bolus and provides no support for Petitioner's contention that transmission requires digital encoding. *See, e.g.*, Pet. at 32 (citing Ex. 1005 at [0058]). Powering a transmission system does not dictate the format of the transmitted data, as analog transmissions also require power.

155. Thus, Risky does not inherently require sensor data to be encoded as digital for transmission, as Petitioners and Professor Young assume. The presence of a transmitter, polling operations, and bolus identifiers like a MAC address or UAID does not mean that any sensor signals must be converted to a digital format. Because Risky allows for the possibility of analog transmission of sensor signals, Petitioner has failed to establish that element 5[C] is inherently disclosed.

4. “ADC” Is Not Necessarily Present in Risky

156. Professor Young and Petitioners also contend that an “ADC” must be used to convert analog sensor signals into digital form, such as “PCM-encoded data.” However, neither ADC nor PCM-encoded data is expressly disclosed or inherently required by Risky. I reviewed Risky in its entirety, and Risky never mentions “ADC,” “PCM,” or “converting” data, and none of the systems it describes necessarily requires these features. Professor Young and Petitioners cite paragraphs 41, 43, and 44 of Risky, but those paragraphs merely describe the “memory unit” and “polling” of sensors discussed above, which do not require sensor signals be encoded, and they do not require the use of an ADC. I further note that ADC may be required for digital storage and communication, but it has a power cost, which in fact provides a reason not to use an ADC in a bolus system. Element 5[D]: “storing said encoded physiological data in a non-transitory computer readable media”

157. Risky also fails to teach “storing said encoded physiological data” as required by element 5[D]. For element 5[D], Professor Young and Petitioners rely on the same “memory unit” in Risky addressed above in Section X.A.1. *See, e.g.*, Pet. at 32-35; Ex. 1002 at ¶¶ 88-90. And as I explained above, a POSA would understand that Risky fails to explicitly or inherently disclose that any “physiological data” is encoded when it is stored. *See* Sections X.A.1-2, 4. Also, even if the alleged *transmitted* physiological data in Risky were “encoded”—which

is not inherent (*see* Section X.A.3)—Riskey never states that such data was encoded when it was stored, nor would it need to be. For example, it is possible for physiological data to be encoded after storage and before or during transmission, where such a design could potentially be used to save power. *See* Section VIII.D above. Moreover, encoding of data can occur after the transmission process in the reader where the power constraint is much less, and Riskey does not rule out that possibility either. Riskey therefore fails to establish that Riskey expressly or inherently discloses element 5[D] and thus does not anticipate claim 5 or 6 for these additional reasons.

B. Element 5[F]: “activating said radio signal generator at pre-determined intervals to generate a radio signal to carry said encoded physiological data”

158. Petitioners and Professor Young do not establish that Riskey discloses “activating said radio signal generator at pre-determined intervals to generate a radio signal to carry said encoded physiological data,” as required by element 5[F]. For this element, Petitioners and Professor Young rely on two embodiments in Riskey that discuss a transmission interval or transmission frequency: (i) “burst” mode, and (ii) “on-line” mode. Pet. at 36-37; Ex. 1002 at ¶¶ 92-93. Based on my review, Riskey does not provide disclosures indicating that the transmission interval or transmission frequency in either of these embodiments is “pre-determined.” Petitioners and Professor Young do not argue that this element was inherent. As

explained further below, in “burst” mode, sensor data is polled and then stored in a “memory” unit to be transmitted in “bursts,” rather than instantaneously. *See* Ex. 1005 at [0049]. Professor Young and Petitioners rely on Risky’s reference to a “transmission interval” determined by a processor used in burst mode. But based on Risky’s teaching as a whole, a POSA would understand that the “interval” relied upon is not “pre-determined.” Instead, the interval would be understood to vary based on changes in the animal’s health conditions and triggering events determined by the processor. Risky further teaches that the distribution of the physiological parameter and a decision will be made by comparing with the previous data and a threshold.

159. Similarly, a POSA would understand that the “interval” in the “on-line” mode relied on by Petitioners and Professor Young relates to transmissions of bolus identifiers and not the encoded physiological data required by claim 5. *See* Ex. 1005 at [0053]-[0055]. Based on Risky’s teachings as a whole, a POSA would understand that any physiological data transmitted in the online mode would be sent in response to a reply message at an undetermined time.

160. In general, Risky only describes systems that transmit messages including animal data at intervals in response to different triggering events that can occur at any given time, not at pre-determined intervals. As I discussed above, Risky purports to monitor animals by using a processor that adapts or varies the

frequency of transmissions based on certain changes that occur, such as changes in the animal's health, location, or temperature. See Section VII.A above. Risky's goal in linking transmission frequencies to changes was to send messages relating to those changes as soon as possible after they occurred, and the noises in the sensor measurement are countered by the distribution of the physiological parameters. For example, Risky explains that its processor may increase a transmission frequency in response to changes in the animal's location so that the animal manager is aware of that condition sooner. Ex. 1005 at [0048], [0142] (“[S]ome health conditions may require responsive action by an animal manager.”), [0020] (“The base station 40 and/or computing device 42 may be monitored by and/or in communication with an animal manager. As used herein, an animal manager may refer to any person, machine, and/or used to manage one or more animals. The animal manager may be in charge of and/or responsible for one or more animals monitored by the systems and methods disclosed herein.”). A POSA would understand from Risky's stated goal for such systems is that its transmitter sends messages at frequencies based on events corresponding to changes in animal conditions, instead of at a set predetermined interval.

161. With respect to the “burst” mode specifically, I disagree with Petitioners and Professor Young that Risky teaches activating said radio signal generator at predetermined intervals to generate a radio signal to carry said encoded

physiological data. According to Petitioners and Professor Young, Risky teaches this element because “[f]or example, in ‘burst’ mode, the transmitter is activated at predetermined, periodic intervals.” Pet. at 36-37; Ex. 1002 at ¶ 92. In discussing this embodiment, Risky states that “machine readable instructions 252 may specify a transmission inter[v]al, wherein processor 240 may transmit an animal characteristics message ... at each transmission interval.” Ex. 1005 at [0049]. Notably, paragraph 49 itself does not provide specific details on exactly how the instructions implement the “intervals,” and a POSA would look to Risky’s teachings as a whole, including in the surrounding paragraphs, for additional context to get an understanding of how the processor and machine readable instructions operate in the burst mode. In doing so, a POSA reading Risky would understand that the “transmission interval” in Risky is not pre-determined, but dependent on triggering events that affect the delay applied between transmissions. Specifically, when Risky refers to “intervals” between events and the “frequency” of events, they are always conditional on the occurrence of other events including polling that affect the transmission delay, and not pre-determined. Hence, a POSA would apply that understanding to the intervals in the burst mode that are set by a processor and its instructions. For example, Risky explains that machine-readable instructions 252 may define “conditions” under which processor 240 changes sensor sampling frequency, polling frequency, or **transmission frequency**, e.g., based on a threshold

animal temperature, health condition, or location. Ex. 1004 at [0048]. Risky explains, “[f]or example, the processor 240 may increase a polling and/or **transmission frequency** when the animal is in the vicinity of a calving pen and/or hospital pen, and may decrease the polling and/or transmission frequency when the animal is moved out of the pen.” Ex. 1004 at [0048]. A POSA would understand that such changes increase or decrease the transmission interval (or transmission frequency) in real-time, meaning they are not pre-determined as claimed. In short, a POSA would understand that the transmission interval adapts to the varying conditions related to the animal, even in the burst mode, and it therefore cannot be “pre-determined.”

162. With respect to “online” mode, I disagree with Petitioners and Professor Young that Risky discloses activating the transmitter at pre-determined intervals to generate a radio signal to carry said encoded physiological data. According to Petitioners and Professor Young, in Risky’s “online” mode “the transmitter is activated at a predetermined ‘transmission frequency’—*i.e.*, transmission interval—specified by the device’s machine readable instructions.” Pet. at 37 (citing Ex. 1005 at [0055]; Ex. 1002 at ¶ 93 (same)). Petitioners and Professor Young completely overlook that “transmission” alone does not meet the challenged claims. Per the challenged claims, the relevant signal sent at pre-determined intervals must carry the animal’s physiological data. But based on Risky’s teachings as a whole, that is not

how a POSA would understand Risky's "online" mode to operate. In "on-line" mode, Risky's processor requires a complex communication unit, which comprises the transmitter, to transmit a "discovery message at a set interval" (which a POSA would understand is a "ping") to a base station or transceiver. Ex. 1005 at [0037] ("Communications unit 230 may comprise active data transmitter 232 and data receiver 234."), [0053] ("In one embodiment, communications unit 230 may detect whether bolus 210 is within range of a receiver, such as a base station (not shown) or transceiver (not shown). Processor 240 may cause communications unit 230 to transmit a discovery message at a set interval."). Risky explains that this discovery message is a "simple message" that "may be referred to as a 'ping' and may include one or more of the unique identifiers associated with a particular bolus 10 (e.g., a MAC, UAID, and/or UBID)." *Id.* That message may include a unique ID, but it does not include "encoded physiological data" as required by the claim in the '644 Patent. Risky further explains that the device in this embodiment may be configured for "online" mode, and the transmitter in turn may be activated to transmit animal characteristics messages, only "[u]pon receipt of a reply message" from the base state or transceiver. *Id.* In other words, the transmitter is activated based on threshold conditions that must be met first, and it is not activated at a pre-determined interval of time.

163. Note that this additional polling step in the on-line mode relieves the requirements of clock synchronization between the bolus sensor and the external reader, and represents a different design choice from the pre-determined intervals in Claim 5 of the '644 Patent. For long-term operations, synchronization between the bolus and the reader cannot be assumed to be valid always, and the polling solution can relieve this problem at the energy cost of polling and sensor response thresholding.

164. A POSA would have further understood that an animal monitoring method that transmits physiological data at “pre-determined intervals” operates in a different way and serves a different purpose than Risky’s “burst” or “online” modes, especially when the power consumption of the bolus system is stringent. As discussed above, one goal of the '644 Patent was to use less power so that the bolus can be administered to an animal over the entire productive lifespan of the animal, which can be about seven years. See Section V.A above. The claimed “pre-determined interval” method is an effective way to accomplish that goal by transmitting physiological data *only* at certain times to save power. For example, in the claimed method, no energy will be consumed by decisions made by the microprocessor for polling and sensor noise accommodation. This allows for a smaller battery and thus a smaller bolus that can be administered at birth, such as to a small calf. Risky’s “burst mode” is not implemented to save power or reduce the

size of the bolus. The goal of burst mode is to gather data in the bolus until a triggering event occurs, and only then send the data when instructed by a processor. This allows the system to recognize changes in the animal as soon as possible. Modifying Risky's burst mode such that it transmits physiological data only at a constant pre-determined interval, regardless of triggering events, would defeat that purpose.

165. Modifying Risky's "online" mode to transmit physiological data at pre-determined intervals would also defeat the purpose of that mode. In the online mode, the bolus is always on line so that it can listen for a reply message from the reader in response to a ping. If it receives a response, it will then send data relating to the animal. A POSA would understand that the purpose of Risky's online mode is for data to be sent and received any time the bolus and reader are in a "hand-shaking" communication, so that the system accumulates as much data as possible. A POSA would not understand saving power to be a factor or reason to implement online mode. A POSA would understand that a bolus employing Risky's "online" mode would use substantially more power than with the claimed method.

166. In short, Risky does not disclose "activating" step under either embodiment asserted by Petitioners and Professor Young. For at least these reasons, Petitioners and Professor Young do not establish that Risky discloses each and every element of the challenged claims. It is therefore my opinion that Risky does

not anticipate claims 5 and 6, and Ground 2 does not show the challenged claims to be unpatentable.

C. Elements 5[A] and 5[B]: “generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal, said sensor signal varies based on a corresponding change in one or more physiological parameters of said ruminant animal”

167. Claim 5 recites “[A] generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal, [B] said sensor signal varies based on a corresponding change in one or more physiological parameters of said ruminant animal.” A POSA would understand this to require a sensor that generates a signal that directly follows the changes in a physiological parameter inside an animal. When claim 5 states “generating a sensor signal from one or more sensors” and that “*said* sensor signal varies based on a corresponding change” in physiological parameters, a POSA would understand the signal that “varies” must be the same signal that was generated by the claimed “one or more sensors.” Risky does not expressly or inherently teach that.

168. With respect to element 5[A], Professor Young argues that “Risky describes using sensors 220 to monitor several physiological parameters, including temperature, pH, heart rate, respiration, and stomach or rumen contractions.” Ex. 1002 at ¶ 83. He further contends that a “POSA would understand that these sensors

necessarily generate signals representing the physiological parameters they are measuring.” *Id.*

169. With respect to element 5[B], Professor Young argues:

A POSA would further understand that the generated sensor signals would necessarily vary in accordance with changes in the measured physiological parameters. An animal’s temperature, heart rate, respiration, etc. will change over time. *See id.*, [0035] (detecting animal temperature, stomach contractions, *etc.*), [0044] (‘sensor 220 may have a sensor reading duration to allow sensor 220 to measure animal characteristics over time’). To distinguish a first measured value (*e.g.*, temperature of 101 degrees) from a second measured value (*e.g.*, 103 degrees), the sensor signal must vary in accordance with the two-degree change in temperature. For instance, Risky discloses use of a ‘thermistor’ ([0035]), which is a device that changes its resistance as a function of temperature, and thereby is used to generate a signal that varies as a function of temperature. Similarly, Risky discloses use of a ‘thermocouple’ ([0035]), which is a device comprising two dissimilar metals that generates a voltage that varies as a function of the junction temperature. A POSA would further understand that signal variation is inherent in any signal representing a changing parameter such as those disclosed in Risky, and therefore signal variation is inherent for a sensor measuring such a changing/varying parameter.

Ex. 1002 ¶84.

170. However, the two paragraphs cited by Professor Young do not demonstrate that Risky’s sensors necessarily produce a “sensor signal” that “varies

based on a corresponding change in one or more physiological parameters,” as required by Claim 5. Neither paragraph 35 nor paragraph 44 in Risky describes the generation of a signal that varies directly with a physiological parameter. They do not support Professor Young’s suggestion that Risky “distinguish[es] a first measured value ... from a second measured value,” which is his basis for determining that the sensors in Risky produce “varying” signals. Even assuming variation in temperature of the animal, the paragraphs cited do not expressly disclose any signal being generated by the sensor at all, just that measurements can be taken and later processed. These paragraphs merely describe the presence of sensors that may be capable of detecting characteristics and storing data, but they do not describe how any generated signal varies to directly correspond to a change in the underlying physiological parameter. Moreover, I disagree with Professor Young’s statement that a “POSA would further understand that signal variation is inherent in any signal representing a changing parameter such as those disclosed in Risky, and therefore signal variation is inherent for a sensor measuring such a changing/varying parameter.” This statement is circular because it assumes a change of 101 to 103 degrees, which requires an assumption that any signal variation corresponds to a changing/varying parameter. However, he fails to account for the fact that signals include “noise.” Professor Young and the cited paragraphs in Risky (¶¶ 35 and 44) do not address that the “variation” could be noise, which would not correspond to a

change in physiological parameter as claimed. Because the variation could be noise, “generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal, said sensor signal varies based on a corresponding change in one or more physiological parameters of said ruminant animal” is not necessarily present in the alleged “signals” identified by Professor Young.

171. Specifically, paragraph 35 of Risky states:

One or more sensors 220 of bolus 210 may be used to detect physiological characteristics of an animal including, but not limited to: body temperature; heart rate; respiration; stomach contractions; stomach pH; blood pH; and the like. Any number of sensors 220 may be used to detect such characteristics. For example, to detect animal temperature, a temperature sensor 222 may be employed. In this embodiment, temperature sensor 222 may comprise a thermistor, thermocouples or a platinum resistance thermometer, or the like.

Ex. 1005 ¶35. A POSA would understand that this paragraph describes the types of sensors that may be used in the system, not the nature of any signal they generate. The mention of thermistors and thermocouples does not imply that a signal is generated in a manner that reflects a change in a corresponding physiological parameter, as required by the claim. While a thermistor or thermocouple may respond to temperature with changes in resistance or voltage respectively, these raw electrical properties are not themselves a generated sensor signal. See Section

VIII.A.1-3 above. Nor does Risky state that the system is configured to output those values as-is (e.g., as an analog voltage). Additional circuitry is required to extract, condition, or encode such signals—none of which is described. *Id.* Thus, paragraph 35 of Risky provides no information regarding whether or how a sensor signal is generated, let alone whether such a signal varies in response to changes in a physiological parameter as claimed, or, for example, merely a result of noise. Therefore, Risky’s discussion of sensors in paragraph 35 does not inherently disclose “generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal, said sensor signal varies based on a corresponding change in one or more physiological parameters of said ruminant animal.”

172. The other paragraph cited by Professor Young, paragraph 44 of Risky, states:

In another embodiment, sensor 220 may alternatively comprise a memory storage location to store sensor samples. In this embodiment, processor 240 may poll sensor 220 by reading a sensor 220 storage location. In another embodiment, sensor 220 may have a sensor reading duration to allow sensor 220 to measure animal characteristics over time (e.g., an accelerometer sensor 221). Sensor 220 may store such measurements on an internal sensor storage location or on memory unit 250. The processor 240 may poll such a sensor by reading memory 250 or the internal storage location of the sensor 220. In this embodiment,

processor 240 may be configured to pre-process the measurement data before transmission. Such preprocessing may comprise calculating a measurement characteristic, such as mean, standard deviation, etc., compressing the data, and the like. As such, the preprocessing may reduce the amount of data transmitted to the base station (not shown) and thereby reduce power and RF transmission requirements”

Ex. 1005 ¶44. A POSA would interpret this paragraph as describing an architecture where measurement samples are stored in memory and optionally pre-processed before transmission. A POSA would understand that storing an internal value—e.g., a voltage corresponding to temperature—does not necessarily require signal generation. For example, it is possible for the sensor to perform an internal measurement using analog hardware (e.g., a voltage divider in the case of a thermistor), but not output a signal at the time of measurement. The measured voltage might remain internal to the sensor (e.g., held on a capacitor or stored in analog EEPROM) until the processor chooses to read it. A POSA would also recognize that in a pre-processed embodiment, the signal being generated is not an output of a signal directly representing changes in temperature, but rather a derived signal that may be a statistical summary—such as a mean or standard deviation—of many underlying samples. As a result, even if those samples reflect changes in temperature, a POSA would understand that the *generated signal* itself is a

transformed output that is not inherently varying with the underlying physiological parameter at the time of measurement.

173. Accordingly, I disagree with Professor Young’s assertion that signal variation corresponding to a changing physiological parameter is inherent in any of the alleged signals generated by Risky’s described system. Neither Professor Young nor the portions of Risky that he cites describe how sensor signals are generated, processed, or output, let alone in a manner that varies based on a corresponding change in the measured physiological parameter. And such variation is not necessarily present. For example, the system described in Risky may employ discrete sampling, onboard preprocessing, and delayed transmission, all of which prevent a POSA from concluding that the “sensor signal” generated by the sensor varies as the physiological parameter changes.

174. Based on a POSA’s understanding of the claim requirements and Risky’s teachings, Risky does not teach “generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal,” where “said sensor signal varies based on a corresponding change in one or more physiological parameters of said ruminant animal,” as argued by Petitioners and Professor Young.

XI. GROUND 3: CLAIMS 5 AND 6 ARE NOT RENDERED OBVIOUS BY HARVEY IN COMBINATION WITH RISKEY

175. In my opinion, claims 5 and 6 of the '644 Patent are not rendered obvious by a combination of Harvey and Risky.

A. General Comments on Petitioners' "Obviousness" Ground

176. I understand that to show obviousness, Petitioners and Professor Young must specify differences between the claims and the prior art and must explain how and why a POSA would modify the prior art to meet the claim. I have reviewed the Petition and Professor Young's declaration and have not seen an identification of differences between the claims and Harvey or Risky. I also have not seen an explanation of how or why a POSA would modify Harvey in view of Risky, or vice versa, to include any missing or different elements. *See* above Section IX (Harvey) and Section X (Risky) for elements missing from both references, including common elements missing from both references (Sections IX.B-D and X.A-B). Petitioners and Professor Young do not specify any claim elements that are missing. Instead, they both offer a general combination asserting:

To the extent Patent Owner alleges that either Harvey or Risky fails to teach any claim element, that element is provided by the other reference. Further, to the extent the teachings of Harvey are substantively different than Risky for any given claim element, it would have been at least obvious to try Risky's implementation of that

element in Harvey, or vice versa, given the overall similarity in their purpose, design and operation.

Pet. at 42; Ex. 1002 at ¶ 101. Petitioners and Professor Young do not identify a primary reference, the missing elements of that reference, or what teachings of the secondary reference should be applied. For example, while Petitioners and Professor Young's Ground 3 heading may suggest Harvey as a primary reference, I do not see that they identify any specific element missing in Harvey, the teachings in Risky that should be combined with Harvey for such element, or how and why a POSA would have modified Harvey in view of Risky to achieve claims 5 and 6.

177. In summary, I do not see that Petitioners or Professor Young identify any specific difference between Harvey, Risky, and the claims. I also do not see that they have provided a reason to modify Harvey or Risky in combination with each other.

B. There Would Have Been No Reason to Combine Harvey and Risky

178. In my opinion, there would have been no reason to combine Harvey and Risky with each other. According to Petitioners and Professor Young, "Harvey and Risky teach the same kind of device which is used for the same purpose," "Harvey and Risky both recognized and solved [the] same problem," and "Harvey and Risky came up with the same solution to the problem." Ex. 1002 at ¶¶ 98, 100; Pet. at 40-42; *see also* Ex. 1002 at ¶¶ 96-97; Pet. at 38-39. If that were true, a POSA

would have no reason to combine the references because they do not teach anything new to each other. Specifically, a POSA would not modify Harvey based on Risky to solve any problem because, as Petitioners and Professor Young contend, Harvey already solved the same problem as Risky and in the same way. Likewise, a POSA would not turn to Harvey to modify Risky because, again, Harvey already purports to solve that same problem as Risky and in the same way.

179. Petitioners and Professor Young also do not explain why a POSA would have had a reasonable expectation of success in modifying Harvey and Risky in view of each other. For example, Professor Young merely states that “the technology and operation of such components was well-understood in the relevant time period such that the combination of Harvey and Risky would have had a high likelihood of success” without further explanation or sources to back up his opinion. In my opinion, the technology and operation of the claimed components and method steps were not well-understood in combination at the time of the invention, as evidenced by the missing elements from each reference discussed above in Sections X and XI above.

180. In short, because Harvey and Risky provided the same solution for the same problem, a POSA would have understood that the two references add nothing new each other. Therefore, there would have been no motivation for a POSA to

modify either reference in view of the other with a reasonable expectation of success, and a POSA would never have sought to combine them.

C. No Combination Is Shown to Meet All Elements of the Challenged Claims

181. As I discussed above, Petitioners and Professor Young have not identified any specific differences between the references such that a POSA would combine them. The only element addressed in Ground 3 is the requirement that boluses be “orally administered,” but Petitioners and Professor Young do not explain how the combination of Harvey and Risky somehow renders that requirement obvious. In any event, the alleged obviousness of “oral administration” does not address any of the deficiencies over and differences from ’644 Patent claims which I have identified in Harvey and Risky.

182. As I discussed above in connection with Grounds 1 and 2, Petitioners and Professor Young do not establish that Harvey and Risky disclose a number of elements required by the challenge claims, including that neither reference discloses activating a radio signal generator at “pre-determined intervals” to carry “physiological data” or the claimed “encoding” and “storing” steps. See Sections IX.B-D, X.A-B. Accordingly, no combination of those references would address the deficiencies I have identified, and nothing in Ground 3 suggests otherwise. Petitioners and Professor Young also do not assert that a POSA would have used the teachings in Risky to add a bolus functionality to Harvey’s ear tags to address the

deficiencies that I have identified in Section IX. Even under the most generous reading of Ground 3, Petitioners and Professor Young do not identify an obviousness combination at all. Therefore, Ground 3 adds nothing to Grounds 1 and 2.

183. Even if it is determined that Petitioners or Professor Young identified an actual combination of Harvey with Risky (which they have not for the reasons above), Petitioners and Professor Young have still not explained how a POSA would have combined any teaching from Risky into Harvey's external ear tag, or vice versa. Petitioners and Professor Young also do not explain why a POSA would have had as reasonable expectation of success in incorporating those teachings. Petitioners and Professor Young do not provide any evidence or explanation to support why a POSA would have had reasonable success in modifying these references in view of each other, much less explain what the modification would have been.

184. For at least the above reasons, Petitioners and Professor Young have not established that a combination of Harvey and Risky meets every element of claims 5 and 6. It is therefore my opinion that Ground 3 does not show the challenged claims to be unpatentable.

XII. GROUND 4: CLAIM 7 IS NOT RENDERED OBVIOUS BY HARVEY IN COMBINATION WITH RETTEDAL

185. In my opinion, claim 7 of the '644 Patent is not rendered obvious by the combination of Harvey in view of Rettedal.

A. The Combination of Harvey and Rettedal Fails to Disclose or Suggest the Invention of Claim 7

186. Ground 4 fails for the same reasons as Ground 1 and the additional reasons below. Claim 7 depends on claim 6, which depends on claim 5. Ex. 1001 at claims 5-7. As I discussed for Ground 1, Harvey fails to disclose many of the elements recited in claim 5, including at least “one or more sensors contained in a bolus,” “encoding said sensor signal,” “storing said encoded physiological data,” “a radio signal generator located within said bolus,” and “activating said radio signal generator at pre-determined intervals to generate a radio signal to carry said encoded physiological data.” See Section IX. Petitioners and Professor Young rely solely on Harvey for these elements in Ground 4, and they do not contend that Rettedal addresses Harvey’s deficiencies. See Pet. at 47-49; Ex. 1002 at ¶¶ 104-111. Thus, Ground 4 necessarily falls with Ground 1.

187. As I explained above, Professor Young and Petitioners failed to establish anticipation at least because they did not connect Harvey’s “bolus” embodiment to its separate “XPDR 5000” embodiment that they argue includes a “sensor” and “radio signal generator.” See Section IX.A.1 above. I note that Rettedal mentions a “bolus,” but neither Petitioners nor Professor Young rely on it as a substitute for Harvey’s alleged “bolus.” Their argument for obviousness based on a combination of Harvey and Rettedal is therefore deficient because it does not address the “sensor” and “radio signal generator” missing from Harvey’s bolus

embodiment. For example, Professor Young and Petitioners do not explain why or how a POSA would have combined Harvey’s “bolus” with its separate “XPDR 5000” embodiment to include those elements. Professor Young and Petitioners do not acknowledge that Harvey’s bolus and XPDR 5000 are different embodiments in either their anticipation or obviousness argument. And they do not rely on Rettedal for those elements. They therefore fail to propose a combination of the two reference that could meet the claims or address the deficiencies identified above for elements 5[A] and 5[E]. See Section IX.A.1 above. Thus, in my opinion, Ground 4 is deficient for the same reasons as Ground 1. I identify additional deficiencies in Ground 4 below.

B. A POSA Would Understand That the Claimed “Matching Elements” Adjust the Signal of “the Radio Signal Generator” to a Desired Frequency

188. Professor Young and Petitioners do not show claim 7 to be obvious based on Harvey and Rettedal at least because Rettedal does not disclose or suggest the “matching elements” recited in claim 7. Claim 7 requires the “matching elements” to “adjust[] said frequency of said radio signal to compensate for a change in said frequency of said radio signal due to passing through a mass of said ruminant animal.” As I explain more below, a POSA would understand that the “change” in frequency stated in the claim is a shift in the “resonant frequency” (or “center frequency”) of the antenna caused by the animal mass. Specifically, the shift in

resonant frequency caused by the animal mass creates a mismatch between the center frequency and the frequency of the signal delivered by the radio signal generator. A POSA would understand that the claimed “matching elements” adjust the antenna’s center frequency property to match the radio signal generator’s output frequency.

189. A POSA would understand that the specification’s discussion of “matching elements” provides an example of the claimed “matching elements.” *See also* Section V.A above. That description and example is consistent with my understanding of the claim described above. The ’644 Patent specification states:

Embodiments of the bolus (1) can further include matching elements (25) which function to match the input impedance of the electrical load or the output impedance of the loads corresponding signal source to maximize the power transfer or minimize signal reflection from the load. In an ideal situation, source impedance and load impedance should be equal to maximize power transfer.

Ex. 1001 at 5:4-16. The patent further states:

Three elements influence the balance of impedance in radio design: the antenna (28) or “load”, the radio signal generator (21) or “source”, and the device’s ground plane. Since each of these elements have different physical characteristics, their corresponding impedances are inherently different. The passive capacitors (26) and inductors (27) that make up the matching elements (25) of embodiments of the bolus (1) are used to mitigate these differences and rebalance the impedance for a given radio signal frequency (23).

Ex. 1001 at 5:11-19.

190. A POSA would understand this to be describing the claimed “matching elements. Specifically, a POSA would understand that the matching elements “function to match the input impedance” of the antenna to the “output impedance” of the radio signal generator “to maximize the power transfer or minimize signal reflection.” Ex. 1001 at 5:4-16. In this context, “gain” refers to the efficiency of the signal transmitted from the antenna. Moreover, “signal reflection” refers to a portion of the signal that is returned from the antenna, and therefore not transmitted, when the antenna’s resonant frequency (center frequency) does not match the output frequency of the radio signal generator. When the bolus is placed inside of the animal, the impedance of the antenna changes. This causes the antenna’s center frequency to shift downward, as explained in the patent. Ex. 1001 at 6:27-32. As the patent states, “[b]ecause the radio signal generator (21) included in embodiments of the bolus (1) operate within the mass of a ruminant animal (3), it has been discovered that the center frequency (the arithmetic mean of the lower cutoff frequency and the upper cutoff frequency) is shifted lower and may not have the maximum gain.” *Id.* The “matching elements” taught by the ’644 Patent compensate for this shift by using a “resonant circuit” comprising “an array of inductors (27) and capacitors (26) used in series or in parallel to balance the circuit impedance.” Ex. 1001 at 5:39–45. The patent further describes these elements as

“passive,” stating, “The passive capacitors (26) and inductors (27)...are used to mitigate these differences [in impedance] and rebalance the impedance for a given radio signal frequency (23).” *Id.* at 5:16-20. The patent then explains that these passive components are configured to “purposefully shift the center frequency” of the antenna “upward and allow[] the radio signal frequency (23) to be re-tuned to a desired radio signal frequency.” Ex. 1001, 6:33–40.

191. Based on the claim language and the description of “matching elements” in the patent, a POSA would understand that the claims involve impedance matching to shift the center frequency of the antenna, and not, for example, to cause the radio signal generator to generate a signal at a different frequency.

C. A POSA Would Understand That Rettedal Does Not Teach the Claimed “Matching Elements”

192. The “network frequency match element” that Petitioners and Professor Young rely on in Rettedal is different from the claimed “matching elements.” For example, Rettedal’s so-called “match element” does not adjust the center frequency of the antenna. Instead, Rettedal describes it as configured to “deliver a particular first radio frequency signal...to the antenna.” Ex. 1006 at [0064]. In other words, it does not adjust the properties of the antenna (i.e., its resonant frequency or center frequency) by impedance matching. It is intended to deliver a specific signal frequency *to the antenna*. For example, Rettedal’s match element supposedly “can

detune a 433 MHz first radio frequency signal (13) to generate a signal of between about 418 MHz and about 425 MHz.” *Id.* That is, it changes the frequency of the signal to generate a specific frequency from the oscillator without changing the antenna’s center frequency.

193. A POSA would understand this design to reflect a different approach to addressing the effects of the animal mass on the system. Instead of shifting (e.g., raising) the antenna’s center frequency, Rettedal’s match element attempts to lower the oscillator’s generated frequency. Ex. 1006 at [0064], Fig. 6. Rettedal does not explicitly state the reason for lowering the generated frequency, but a POSA could presume that this design is intended to more closely match the expected center frequency of the antenna. But in any event, the center frequency of the antenna itself is not adjusted.

194. The structure of Rettedal’s system reflects this design choice. Instead of employing a passive “resonant circuit” with inductors to balance impedances and adjust the center frequency as in the ’644 Patent, Rettedal states that its “match element” is controlled by a “processor element” to actively change the radio signal delivered to the antenna using “capacitors and resistors in combination.” Ex. 1006, [0064]. Rettedal never mentions resonant circuits, inductors, or impedance-balancing.

D. No Reason to Combine or Reasonable Expectation of Success

195. The reason to combine Harvey and Rettedal proposed by Professor Young and Petitioners does not apply to the ear tag device in Harvey that Petitioners rely on. Dr. Young states that “A POSA would have understood, at least from Rettedal, that *the implanted bolus of Harvey* would have experienced this same problem given that the bolus is surrounded by the mass of the animal.” Ex. 1002 at ¶ 108. However, the XPDR 5000 embodiment in Harvey that Professor Young and Petitioners rely on is *not* an implanted bolus. Instead, it is an external ear tag. See Section IX.A above; Ex. 1002 ¶ 111 (citing to Grounds 1 and 3, which rely on XPDR 5000). Because XPDR 5000 is external to the animal, a POSA would not have had a reason to use Rettedal’s “match element” to adjust for the animal’s mass. Therefore, there is no reason to make the proposed combination. Notably, Professor Young and Petitioners do not propose, for example, a combination where XPDR 5000 is reconfigured as a bolus. Therefore, they fail to provide a reason for combining or modifying Harvey’s various embodiments with Rettedal to arrive at the claims for this additional reason.

196. Additionally, because XPDR 5000 is an ear tag, a POSA would not have had a reasonable expectation of success in combining it with Rettedal to arrive at the claims. For example, the electrical sensors used in XPDR 5000 measure alleged physiological data from the *exterior* of an animal and are not possible or practical in

the claimed bolus. See Sections VII.B, VIII.A.4, IX.A.2 above. Additionally, impedance matching in an ear tag (exposed to free air) is very different from impedance matching in the bolus within an animal's reticulum, as the latter has a very different dielectric load due to, for example, the animal's mass and the intake of food and water. Similar to Ground 3, Petitioners and Professor Young make conclusory assertions that claim 7 includes "standard, predictable method steps using a bolus containing well-known, off-the-shelf sensors and radio communication components that would be familiar to any POSA," and that "the technology and operation of such components was well-understood in the relevant time period." Pet. at 46-47; Ex. 1002 at ¶ 109. Without explaining how a POSA could reconfigure Harvey's ear tag into a bolus in a manner that addresses these issue, Petitioners and Professor Young do not show that a POSA would have had a reasonable expectation of success in achieving the claimed invention that requires a bolus.

197. In fact, Professor Young's explanation of "reasonable expectation of success" is a single unsupported statement that "the technology and operation of such components was well-understood in the relevant time period such that the combination of Harvey and Rettedal would have had a high likelihood of success." Ex. 1002 at ¶ 109. Those "components" are, according to Professor Young, "a bolus containing well-known, off-the-shelf sensors and radio communication components that would be familiar to any POSA." *Id.* He does not argue or support that the

specific matching elements, including the inductors and capacitors, discussed above and claimed in the '644 Patent were “well-understood” at the time of the invention. And he does not explain how they would be configured to operate in an animal’s rumen. In fact, at the time of the invention, a POSA would not have been familiar with a device that can generate or deliver a radio signal to an antenna at a specific frequency to compensate for signal demodulation as described in Rettedal.

198. Rettedal itself also does not explain how its “match element” would “adjust[] said frequency of said radio signal to compensate for a change in said frequency of said radio signal due to passing through a mass of said ruminant animal” as claimed. For example, unlike the '644 Patent, Rettedal does not teach the use of a “resonant circuit” to “increase the inductance and capacitance values to purposefully shift the center frequency ... to a desired radio signal frequency.” Ex. 1001, 6:33-40. This design and its operation are critical to achieving the claimed “matching elements,” and are absent from Rettedal. Rettedal merely states that its “match element” is controlled by a processor and “can include capacitors and resistors in combination to deliver a particular first radio frequency signal.” Ex. 1006, [0064]; *see also id.*, [0011], Fig. 6. For example, a POSA would understand that use of a resistor and a capacitor, without additional elements (such as those described in the '644 Patent), would not be sufficient to form a resonant circuit.

XIII. GROUND 5: CLAIMS 9 AND 10 ARE NOT RENDERED OBVIOUS BY HARVEY IN COMBINATION WITH KUNDA

199. In my opinion, claims 9 and 10 of the '644 Patent are not rendered obvious of the combination of Harvey in view of Kunda.

A. The Combination of Harvey and Kunda Does Not Disclose or Suggest the Invention of Claims 9-10

200. Petitioners and Professor Young do not establish that Harvey discloses independent claim 9 for the same reasons that I explained above for claim 5. *See* Section IX. Claims 5 and 9 share many of the same elements, such as “generating a sensor signal from one or more sensors contained in a bolus orally administered to said ruminant animal,” “enabling a radio signal generator located within said bolus,” “encoding said sensor signal from said one or more sensors as encoded physiological data corresponding to said one or more physiological parameters of said ruminant animal,” and “storing said encoded physiological data in a non-transitory computer readable media.” Ex. 1001 at claims 5, 9. As I explained above in Section IX, Harvey does not disclose these elements. *See* Sections IX.A-C above. For claim 9, Petitioners and Professor Young rely solely on Harvey as the primary reference for these same elements, and they do not assert that Kunda addresses any of Harvey’s deficiencies in connection with these elements. *See* Pet. at 55-56; Ex. 1002 at ¶¶ 125, 129.

201. Rather, Petitioners and Professor Young rely on Kunda solely for its purported disclosure of “transmitting said radio signal with an antenna having a pair of electrically conductive loops disposed a distance apart and further comprising transmitting said radio signal through said antenna.” See Pet. at 56-66; Ex. 1002 at ¶¶ 131-138. Petitioners and Professor Young have not shown Kunda teaches the choice of the loop antenna in the bolus sensor in view of what Harvey considered for the animal tag. Moreover, as Harvey did not focus its central design ideas and transceiver components on the bolus sensor (instead, most Harvey’s considerations surround the ear tag), it is not obvious that the loop antenna in Kunda’s teaching is the effective choice for the bolus sensor in Claim 9.

202. With respect to the “bolus” elements, Professor Young and Petitioners’ combination of Harvey and Kunda in Ground 5 does not address the deficiencies in their anticipation ground (Ground 1). See Section IX.A above. They argue that it would have been obvious to modify Harvey’s digestive tract bolus device with a smaller antenna. See, e.g., Ex. 1002 at ¶ 115. However, even if that were true, Ground 5 would still be deficient because Professor Young and Petitioners do not explain why a POSA would or could have modified Harvey’s bolus embodiment to include the claimed “sensor” and “radio signal generator,” such as from the XPDR 5000 embodiment. Because Professor Young and Petitioners do not acknowledge

the separate embodiments, and do not rely on Kunda for the “bolus” elements, they do not propose a combination that could include every element of the claims.

203. Ground 5 also challenges dependent claim 10, which depends from claim 9. Accordingly, for the same reasons that I explained above with respect to claim 9, Petitioners and Professor Young have not shown that Harvey in view of Kunda renders claim 10 obvious.

B. A POSA Would Not Have Had Reason to Combine Kunda with Harvey

204. In any event, I disagree with Petitioners and Professor Young that a POSA would have been motivated to modify Harvey’s tag to incorporate Kunda’s antenna. As mentioned before, the optimal antenna choice out of the myriad of many conventional designs are a critical design for wireless units in view of not only the operational ambient for the possible detuning and orientation dependence but also the packaging limitation and antenna gains (which in turn affects the wireless link budget and the transceiver power consumption budget). Petitioners and Professor Young assert that the “motivation to add Kunda’s antenna to Harvey’s bolus is explicitly provided in both references. For example, Harvey sought to produce a bolus that would fit within the digestive tract of a monitored animal and emphasized the importance of compactness. Ex. 1004 at 11:10-13 (goal of providing a ‘miniature transponder’); *see also id.* at 18:15-17 (recognizing importance of ‘more compact form factor’). Kunda addresses the same size considerations.” Ex. 1002 at ¶ 115. I

disagree. As I explained above in Section IX.A.1, that is not an accurate characterization of Harvey's limited discussion of a "bolus."

205. A POSA would not have interpreted any statement in Harvey to be directed to "bolus" size concerns. Based on my review of Harvey, the reference does not address any concerns related to the size of a "bolus" or the size of other devices that must fit inside "the digestive tract of a monitored animal." Rather, Harvey's 78-page disclosure focuses on ear tags that are affixed to the exterior of an animal's body, such as cattle ears. *See id.*; Ex. 1004 at 19:10-20:12, Figs. 1, 3A-3B. But Harvey never mentions or suggests a concern related to the size of any bolus or that its "bolus" does not fit within a digestive tract. In an attempt to provide an example of such a suggestion, Professor Young cites Harvey at 18:15-17 for its disclosure of a "more compact form factor." In that disclosure, Harvey is specifically describing that "housing 2300 may have a more compact form factor." *Id.* Harvey's only embodiment of housing 2300 is in Figure 2(c), which depicts the housing with "affixment fitting 2320," as shown below:

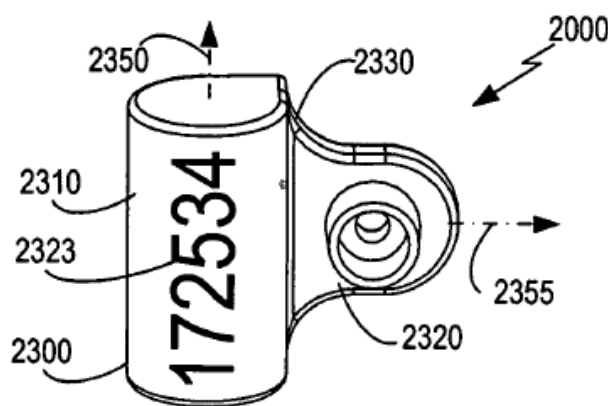


FIG. 2C

Ex. 1004 at Fig. 2C. A POSA would have understood from these disclosures that housing 2300 is the housing of an exterior ear tag based on, for example, that affixment fitting 2320 is illustrated as a pin hole. Ex. 1004 at Fig. 2(c). A POSA would have understood that fitting to be for “pinning” the ear tag to a cattle ear, as depicted in Figure 3A, for example. Ex. 1004 at 19:13-16, Figs. 3A. For a bolus tag, a pin hole would not make any sense in the final packaging. In other words, “affixment fitting 2320” is a pin hole, which is used to pin the tag to animal’s skin, which would not make sense in a bolus. Rather than a bolus, a POSA would have understood the housing related to the “compact form factor” was for an exterior ear tag. Decreasing the size of an ear tag can reduce the burden on the animal and decrease the risk of having the ear tag pulled away, which are not concerns with a bolus. In short, Harvey’s “compact form factor” that Petitioners rely on does not apply to a bolus and does not address any concerns related to a bolus.

206. Moreover, Kunda provides an explicit reason not to use its antenna in Harvey's devices, including to reduce their size. A POSA would have considered it to be impractical to include Kunda's antenna in Harvey's device, where antennas are embedded in a printed circuit board. See Pet. at 24; Ex. 1002 at ¶ 116; Ex. 1004 at 45:12-15 (antennas 5500 and 5501 for RF module 5400 are "embedded in a printed circuit board" or "mounted on a substrate, which may be a printed circuit board"). That is, Harvey teaches that the antennas in its devices should be "embedded in a printed circuit board." Kunda explains that "if the antenna is placed close to a printed circuit board or housing in order to reduce the size of the communication device, that will diminish the characteristics of the antenna." Ex. 1007 at [0005]. Kunda expresses this concern even where the motivation is expressly to reduce size. Based on these teachings in each reference, a POSA would have understood that Harvey teaches placing antennas with the device close to a printed circuit board, which would apply even if Kunda's alleged "double loop antenna" were somehow employed in the device to reduce size. Kunda's statement would have been viewed by a POSA as a warning that such a design, where the antenna is close to the circuit board, would "diminish the characteristics of the antenna." This would discourage a POSA from using Kunda's antennas in Harvey's design.

C. A POSA Would Not Have Had a Reasonable Expectation of Success in Combining Kunda's Antenna with a Bolus

207. A POSA would not have understood that Kunda's antenna is the effective choice in a bolus and thus would not have had a reasonable expectation of success in combining Harvey and Kunda to arrive at claim 9 or 10. Petitioners and Professor Young assert that Kunda's antenna addresses the same "interference" problem solved by the '644 Patent and the same "performance" and "bandwidth" benefits provided by the '644 Patent. *See* Pet. at 50-52; Ex. 1002 at ¶¶ 115-118; Ex. 1001 at 7:20-33. I disagree. Kunda does not describe an antenna capable of counteracting the unique electrical problems experienced when used in a bolus located *inside a body*. Specifically, Kunda discloses fitting a loop antenna to two integrated circuits, where impedance matching in the signal chain is critical to avoid antenna reflection and severe self-jamming to the radio-frequency integration circuits. *See* Ex. 1007 at [0024], Fig. 1 (baseband IC 52 and RFIC 54). Kunda describes a use case of a general communication integrated circuit with a transmitter and receiver, such as for use in mobile phones, where antenna reflection is the key design point. *See id.*; Ex. 1007 at [0001]-[0002].

208. The key design criteria for an antenna within an animal's reticulum are unique and different from Kunda's antenna. Professor Young and Petitioners do not explain how a POSA would have modified Kunda's antenna to meet those criteria and successfully arrive at the claims. For example, Kunda provides no disclosures

suggesting that its antenna could be applied in a device used inside an animal's reticulum, where, for example, impedance mismatching, uncontrollable orientation, and antenna detuning are caused by internal factors, such as the properties of body tissue and complex food mixtures, resulting in significant performance loss, reduced battery life, attenuation, and polarization loss. A POSA would recognize those as necessary design focuses for an antenna in a bolus, which Kunda does not specifically address. A POSA would not be able to conclude from Kunda's disclosures that its antenna works in a bolus. There would thus be no reasonable expectation of success in combining Kunda with any alleged bolus.

209. With respect to Harvey, a POSA also would have understood Kunda to disclose an antenna that was incapable of being included in Harvey's tag device. According to Petitioners and Professor Young, "because Kunda's double-loop antenna saves space," a POSA would consider it "well-suited for use in Harvey's cattle bolus." Pet. at 50; Ex. 1002 at ¶ 115. I disagree. While Kunda contemplates a small antenna, it does not disclose an antenna suitable for use in Harvey's device. As I explained above, Kunda describes fitting a loop antenna to two integrated circuits and a limited use case of a general communication integrated circuit. Based on my review, Harvey does not describe the same or a similar use case.

210. Professor Young and Petitioners also fail to address how to modify Kunda's antenna to have the appropriate size, shape, weight, and operating

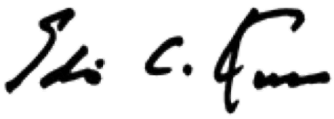
bandwidth to successfully incorporate it into a bolus configuration. Kunda's design may be fit for wireless devices such as a mobile phone. But the size, shape, weight, and operating bandwidth in a bolus would be different, and these are critical design considerations to meet the requirements of a bolus. Moreover, Kunda fails to describe any bio-compatible coating to protect the animal from any harmful materials present in Kunda's antenna that is designed for more general wireless devices. By not addressing the design criteria relevant to a bolus, Petitioners fail to establish that a POSA would have had a reasonable expectation of success in combining Harvey and Kunda to arrive at the claims.

211. Moreover, Petitioners and Professor Young make conclusory assertions that "Claims 9 and 10 consist of standard, predictable method steps using a bolus and antenna containing well-known, off-the-shelf sensors and simple conductive loops that would be familiar to any POSA," and that "the technology and operation of such components was well-understood in the relevant time period such that the combination of Harvey and Kunda would have had a high likelihood of success." Pet. at 52-53; Ex. 1002 at ¶ 119. Petitioners and Professor Young do not provide an explanation or evidence to support their assertion of a reasonable expectation of success in modifying Harvey in view Kunda.

XIV. CONCLUSION

212. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information or belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: April 15, 2025

By: 
Edwin C. Kan, Ph.D.