Filed on behalf of:

Microsoft Corporation and Microsoft Mobile Inc.

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Microsoft Corporation and Microsoft Mobile Inc.,

Petitioner

v.

Global Touch Solutions, LLC,

Patent Owner

IPR2015 – 01148

Patent 7,498,749

EXHIBIT 1011

DECLARATION OF MARK N. HORENSTEIN, PH.D., P.E.

MICROSOFT EXHIBIT 1011
Microsoft v. Global Touch, IPR2015-01148

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I. Introduction & Qualifications

I, Mark N. Horenstein, declare as follows:

1. I understand that Microsoft Corporation ("Microsoft") and Microsoft Mobile Inc. ("Microsoft Mobile") are petitioning the Patent Office for an *inter partes* review of claims 1, 2, 5-7, 14, 15, 21, and 23 of U.S. Patent No. 7,498,749 ("'749 patent"). I have been retained by the Petitioners, Microsoft and Microsoft Mobile, to offer technical opinions relating to the '749 patent and certain prior-art references relating to its subject matter. I understand that an *inter partes* ("between the parties") review begins with a petition for review made by third parties like Microsoft and Microsoft Mobile and responded to by the owner of the patent.

2. I am a Professor of Electrical Engineering in the Department of Electrical and Computer Engineering at Boston University, where I have been a faculty member since 1979. I also have held various other positions at Boston University, including the Associate Dean for Graduate Programs and Research for the College of Engineering (1999-2007), Associate Chair for Undergraduate Programs for the ECE Department (1990 – 1998 and 2012 – present), as well as appointments at the rank of Associate Professor (1985-2000) and Assistant Professor (1979-1985).

3. I have a Ph.D. in Electrical Engineering from the Massachusetts

Institute of Technology (MIT), which I earned in 1978 while working in the Electric Power Systems Engineering Laboratory. I also hold an M.S. degree in Electrical Engineering from the University of California at Berkeley (1975), and an S.B. degree in Electrical Engineering from MIT (1973).

4. I have a number of professional affiliations: I am a Senior Member of the Institute of Electrical and Electronic Engineers (IEEE), the Editor-in-Chief of the Journal of Electrostatics, an ESD Engineer certified by the National Association of Telecommunications and Radio Engineers, and a Registered Professional Engineer (Electrical) in the Commonwealth of Massachusetts. In 2013, I was named an International Fellow by the Industrial Electrostatics Group of the European Federation of Chemical Engineering (EFCE).

5. My primary areas of research are in applied electromagnetics, electronic circuits, electrostatics, and micro-electromechanical systems (MEMS). These disciplines include the topics of capacitive and photonic (*e.g.*, infrared) sensors, micro-actuators and accelerometers, deformable MEMS mirrors for light-wave communication and image processing, and methods for making self-cleaning solar panels.

6. I am the author of two textbooks, *Microelectronic Circuits and Devices* (Prentice-Hall, 2d. ed. 1996) and *Design Concepts for Engineers* (Pearson Education, 5th ed. 2015). I have authored book chapters in two reference books

related to electromagnetics, and I have authored or co-authored over 50 journal articles on a variety of topics in my fields of expertise, and approximately 100 conference papers. I have advised five Ph.D. students performing research in these fields; they have gone on to hold various positions in both industry and academia. I am a named inventor on five patents relating to the areas of my expertise.

7. I have taught approximately ten different courses (numerous times) in the above subject areas over the past 34 years, to over 3,000 undergraduate and graduate students. The subject matter of these courses includes circuits and electronics, static and dynamic electromagnetics, antennas, waveguides, *rf* communications, robotics, and engineering design. I have been named "Teacher of the Year" in Engineering at Boston University three times.

8. In the area of sensors and detectors, I have designed several capacitive sensors, MEMS sensors, and infrared detection systems as part of various research projects. I also developed the curriculum for a graduate course in power electronics in the Department of Electrical and Computer Engineering at Boston University, which includes detailed lectures and extensive laboratory experiments.

9. My curriculum vitae, enclosed as Attachment B, contains a more detailed description of my background.

10. I am being compensated at a consulting rate of $275 per hour for my technical analysis in this matter.

II. Materials Reviewed

11. In forming my opinions, I have reviewed the following:

a. U.S. Patent No. 7,498,749 (filed Oct. 30, 2007) ("'749 patent") (Ex. 1001);

b. Prosecution history for the '749 patent ("'749 prosecution history") (Ex. 1002);

c. U.S. Patent No. 6,249,089 (filed Oct. 9, 1998) ("'089 Patent") (Ex. 1003);

d. U.S. Patent No. 6,125,286 (filed June 5, 1997) ("Jahagirdar") (Ex. 1004);

e. U.S. Patent No. 4,053,789 (filed Aug. 27, 1976) ("Schultz") (Ex. 1005);

f. U.S. Patent No. 5,329,577 (filed Dec. 29, 1992) ("Norimatsu") (Ex. 1006);

g. William Buxton et al., *Issues and Techniques in Touch-Sensitive Tablet Input*, 85 PROC. SIGGRAPH CONF. ON COMPUTER GRAPHICS AND INTERACTIVE TECHS. 215, 215-24 (1985) ("Buxton") (Ex. 1007);

h. U.S. Patent No. 4,963,793 (filed Mar. 8, 1988) ("DePauli") (Ex. 1008); and

i. U.S. Patent No. 4,764,708 (filed Dec. 8, 1986) ("Roudeski") (Ex. 1009).

III. The Law

12. I am not an attorney and do not purport to provide any expert opinions on the law. I have, however, been advised of certain basic legal principles applicable to the analysis set forth in this report. I have assumed these principles to be correct and applicable for purposes of my analysis. I set forth those principles below.

A. Obviousness Analysis

13. I understand that a patent claim is invalid as obvious if the differences between the patented subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art.

14. I further understand that a person of ordinary skill in the art is a person of ordinary creativity, not an automaton, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle. I understand that the obviousness analysis is flexible, taking into account the interrelated teachings of several patents, the effects of demands known to the design community or present in the marketplace, and the background knowledge of a person of ordinary skill in the art. I understand that the

combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.

15. I have been instructed that an obviousness inquiry requires a four-step analysis involving the so called *Graham* factors:

(1) determining the scope and content of the prior art;

(2) ascertaining the differences between the prior art and the claims at issue;

(3) resolving the level of ordinary skill in the pertinent art; and

(4) evaluating objective considerations.

16. Once these determinations have been made, I understand that one must decide, in view of the evidence regarding these four factors, whether or not the invention, considered as a whole, would have been obvious to one having ordinary skill in the relevant art at the time that the alleged invention was made.

17. I am told that one must keep in mind that it is not permissible to use hindsight in assessing whether or not the claimed invention is actually invalid for obviousness. One cannot look at the invention knowing what persons of ordinary skill in the art know today. Rather, one must place oneself in the shoes of a person having ordinary skill in the field of technology of the patent at the time the invention was made.

B. Level of Ordinary Skill in the Art

18. To determine the level of ordinary skill in field of art, I've been instructed that there are no exhaustive factors that may be considered, and I've been instructed to consider the following, to the extent that I can, in opining on the level of ordinary skill in the field of art pertaining to the '749 patent:

(1) The educational level of the inventor;

(2) Types of problems encountered in the art;

(3) Prior art solutions to those problems;

(4) Rapidity with which innovations are made;

(5) Sophistication of the technology; and

(6) Educational level of active workers in the field.

C. Objective Considerations

19. Regarding the fourth step in the four-step process for assessing obviousness, specifically the step involving "objective considerations," I have been told that some of the factors that may be considered are those of copying, a long felt but unsolved need, failure of others, commercial success, unexpected results created by the claimed invention, unexpected properties of the claimed invention, licenses showing industry respect for the invention, and skepticism of skilled artisans before the invention was made. I have no reason to believe that any of these factors apply to the challenged claims of the '749 patent.

D. Claim Construction

20. I understand that in an *inter partes* review at the patent office, claims are to be given their broadest reasonable interpretation in light of the specification as would be read by a person of ordinary skill in the relevant art.

IV. Level of Ordinary Skill in the Art

21. In reviewing and evaluating the '749 patent to determine the level of ordinary skill in the art, I have arrived at my opinion that the "art" found in the '749 patent pertains primarily to electronic circuitry. The art also includes some degree of what the patent calls an "MMI" (man-machine interface), although only at a rudimentary level necessary to appreciate the different types of inputs one might use for the type of devices discussed in the '749 patent.

22. The discussions in the '749 patent about microchips and their role in controlling remote switches are topics that would have been well known to a student midway through a bachelor's degree curriculum in electrical or computer engineering (EE or CE) in the 2007 time frame (the year of filing of the '749 patent) and also the 1998/1999 time frame (the earliest claimed priority dates for the '749 patent). In either time frame, these topics would have been routine and well within the scope of a student at this level of education. Likewise, timers, control circuits, and solid-state switches (*e.g.*, transistors), and especially flashlights-- all relevant to the '749 patent-- were features of minimal electronic sophistication that would have been routine subject matter for an upper-class EE or

CE student.

23. A few of the concepts described in the '749 specification, for example those of series-connected microchips and floating grounds, may have required the skilled person to have had some additional experience beyond an undergraduate EE or CE degree. Based on all these factors, it is thus my opinion that an artisan of ordinary skill in this area at the time of the invention would have a B.S. in electrical engineering or commensurate degree such as computer engineering, or alternatively, some coursework comparable in the area of circuit design, in combination with a year or two of practical experience with products containing electronic circuitry.

V. Claim Construction

24. As I state above, I understand that in IPR proceedings, the claim terms in the '749 patent are to be given their broadest reasonable interpretation as would be understood by a person of ordinary skill in the art at the time of invention. Under this standard, it is my opinion that, aside from the terms otherwise construed below, the terms in the Challenged Claims should be given their broadest reasonable interpretation in light of the specification, as would be commonly understood by those of ordinary skill in the art. I understand that the '749 patent application was filed in 2007, but claims priority to applications filed as early as 1998 and 1999. My views on the meaning of the terms of the Challenged Claims

are the same regardless of the timeframe considered.

A. "non-mains" (claims 7 & 15)

25. In my opinion, the term "non-mains" would be understood by a person of ordinary skill in the art at the time of the invention to mean "not from the AC utility wiring system of a building."

26. The term "non-mains" presents some ambiguity, because this term does not appear in the specification. However, in relation to electrical systems, the term "mains" refers to the AC utility wiring system of a building. This usage is prevalent in countries that are current or former members of the United Kingdom. Given that the inventor Bruwer resided in South Africa (ZA) at the time of patent issue, this meaning of "non-mains" makes sense. Read in the context of claims 7 and 15, a power source that is "non-mains" relates to a power source that is not from the AC utility wiring system of a building. For example, a battery is a type of power source that is separate from the AC utility wiring system of a building.

VI. Obviousness – Overview

27. In my opinion, for the reasons set forth below, the Challenged Claims of the '749 patent would have been obvious to one of ordinary skill in the art in 1998, the earliest possible effective filing date of the '749 patent. I reached this conclusion primarily in view of Jahagirdar (Ex. 1004), which teaches, among other things, microchip-controlled user interfaces, but also in view of well-known

principles of touch sensing. These principles are embodied in several references, including computer and telephone prior art, that I will also discuss. By way of summary, it is my opinion that the Challenged Claims are obvious in view of Jahagirdar and known proximity sensor technology, *e.g.*, Schultz (Ex. 1005), as discussed below.

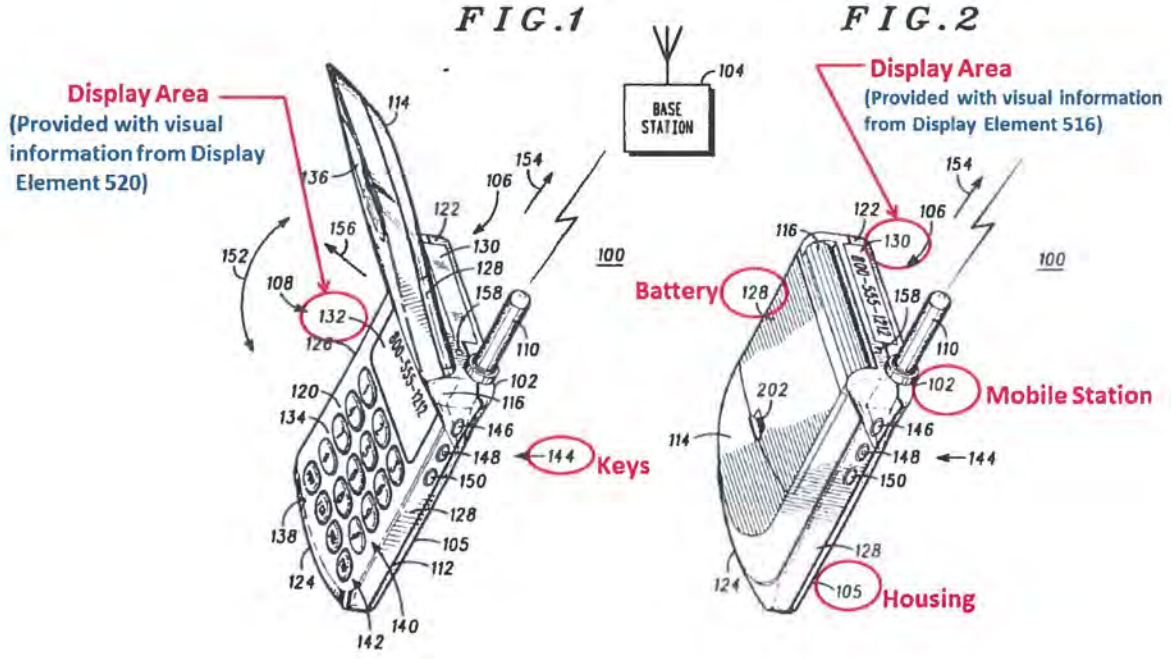
28. In following the analytical framework for obviousness that has been explained to me, I will first discuss the scope and content of the prior art, then analyze each claim to show where the limitations of the claim are present in the prior art. I will also discuss why one of skill would have been motivated to combine the prior art accordingly. I have already set forth above the level of skill for a person skilled in the art in the time frame of the '749 patent. *See supra* Section IV.

VII. Obviousness - Description of Prior-Art Jahagirdar Patent

29. Jahagirdar is a U.S. Patent entitled "Communication Device Having Multiple Displays and Method of Operating the Same," that was filed on June 5, 1997. Ex. 1004 (Jahagirdar) at [22], [54]. I understand that Jahagirdar is prior art to the '749 patent. Jahagirdar was directed generally to the field of electronic circuitry applied to MMIs, and in particular to a mobile phone that has a microchip-controlled user interface and mechanical push-button switches. *See id.* at col. 3 ll. 59-67.

30. Jahagirdar described that its electrical circuitry 500 could be used with a product, such as a mobile station 102 (a portable communication device). *Id.* at col. 1 l. 63-col. 2 l. 6, col. 3 ll. 30-31, figs. 1-2.

31. Electrical circuitry 500 included a connection for a power source (battery 128): "[m]obile station 102 also includes a removable battery 128." *Id.* at col. 3 l. 33. Further, electrical circuitry 500 also included a connection for an energy consuming load (display element 520). *Id.* at col. 4 ll. 27-30. As shown in Figures 1 and 2 below, the energy consuming load (display element 520) provided visual information in display area 132: "[d]isplay elements 516 and 520 provide visual information in display areas 130 and 132, respectively." *Id.* at col. 4 ll. 40-41.



With reference again to Figure 5 below, electrical circuitry 500 included a microchip (controller 504) and an electronic circuit (key circuit 513). *Id.* at col. 3 ll. 60-64. Specifically, Jahagirdar explained that "[e]lectrical circuitry 500 includes . . . a key circuit 513." *Id.*

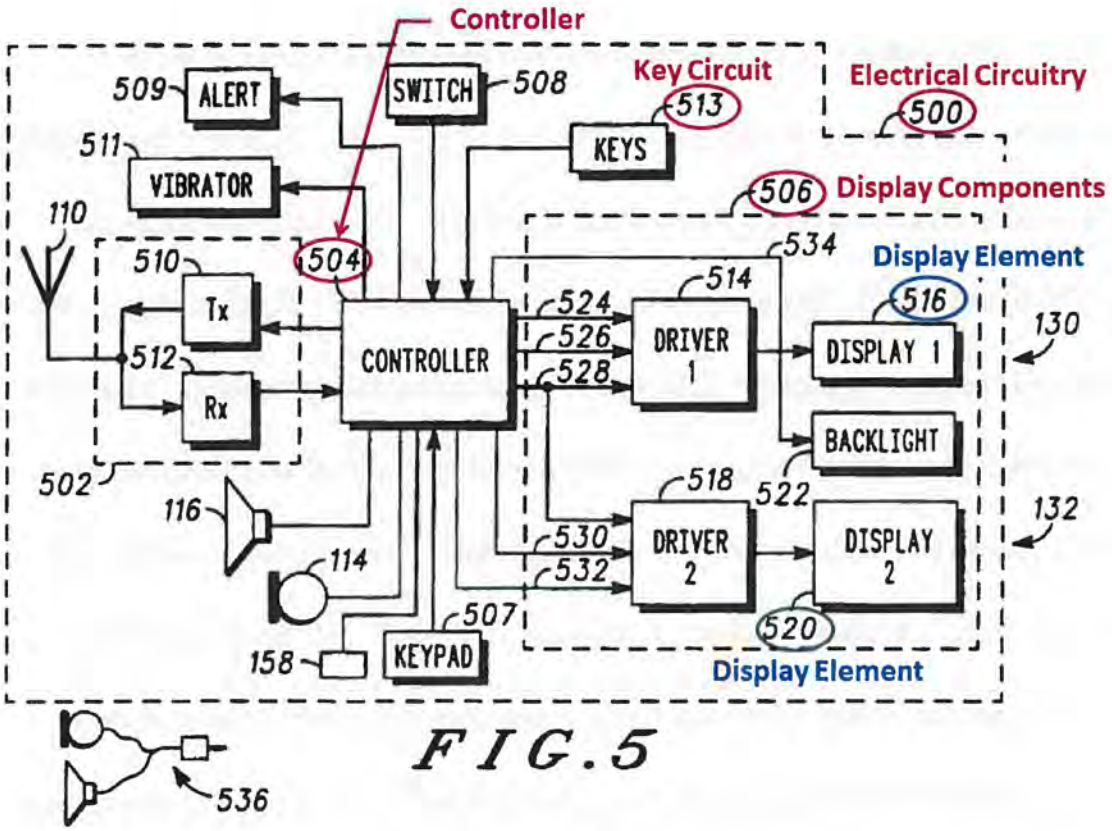


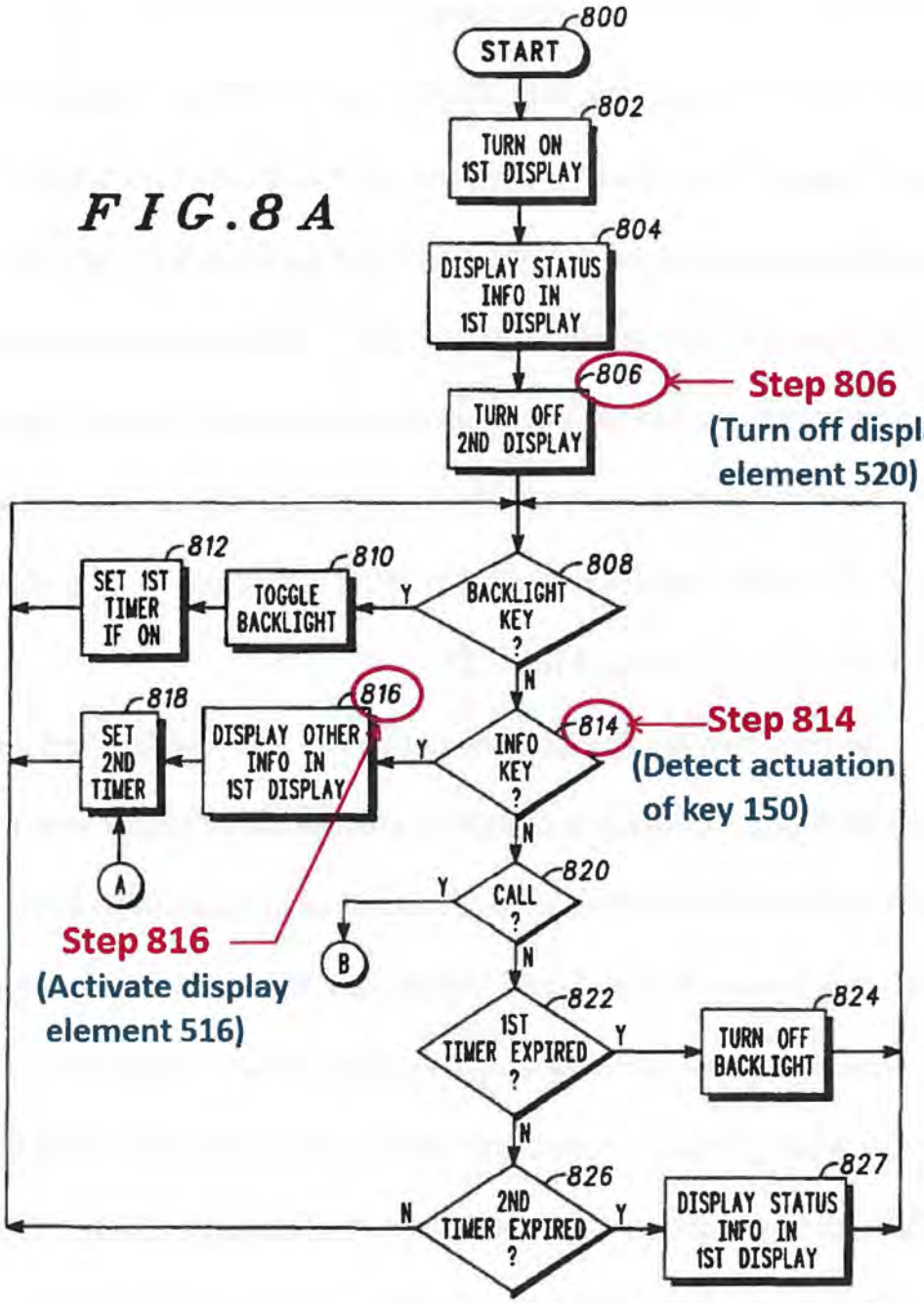
FIG. 5

32. Jahagirdar described that the "key circuit 513 provides signals to controller [504] in response to actuations of the plurality of keys 144." *Id.* at col. 4 ll. 19-20. Jahagirdar's user interface switch structure included this plurality of keys 144. *Id.* at col. 3 ll. 30-31. As shown in Figures 1 and 2 above, the keys 144

were located on the outer housing of the mobile station 102. *Id.* at figs. 1-2. These keys could be used to control various functions of the mobile station 102 such as answering or terminating a call, forwarding a call to voicemail, or displaying information on one of the display areas. *Id.* at col. 6 ll. 40-45, col. 7 ll. 5-11, col. 7 ll. 16-20.

33. Jahagirdar's electrical circuitry 500 included a visible indicator (display element 516). *Id.* at col. 3 ll. 60-62, col. 4 ll. 27-30. Specifically, display element 516 could provide an indicator activation function such as displaying visual information in display area 130. *Id.* at col. 5 ll. 54-57. Further, Jahagirdar disclosed that its display element 516 was controlled by the microchip (controller 504) to provide its indicator activation function when a signal was received from key 150 (of keys 144 which were part of Jahagirdar's user interface switch). *Id.* In relation to Figure 8A, shown below, Jahagirdar disclosed "[i]f controller 504 detects an actuation of key 150 (step 814), controller 504 sends display data to driver 514, which sends display data to display element 516. For [sic] displaying new visual information in display area 130." *Id.* at col. 5 ll. 54-57.

FIG. 8A

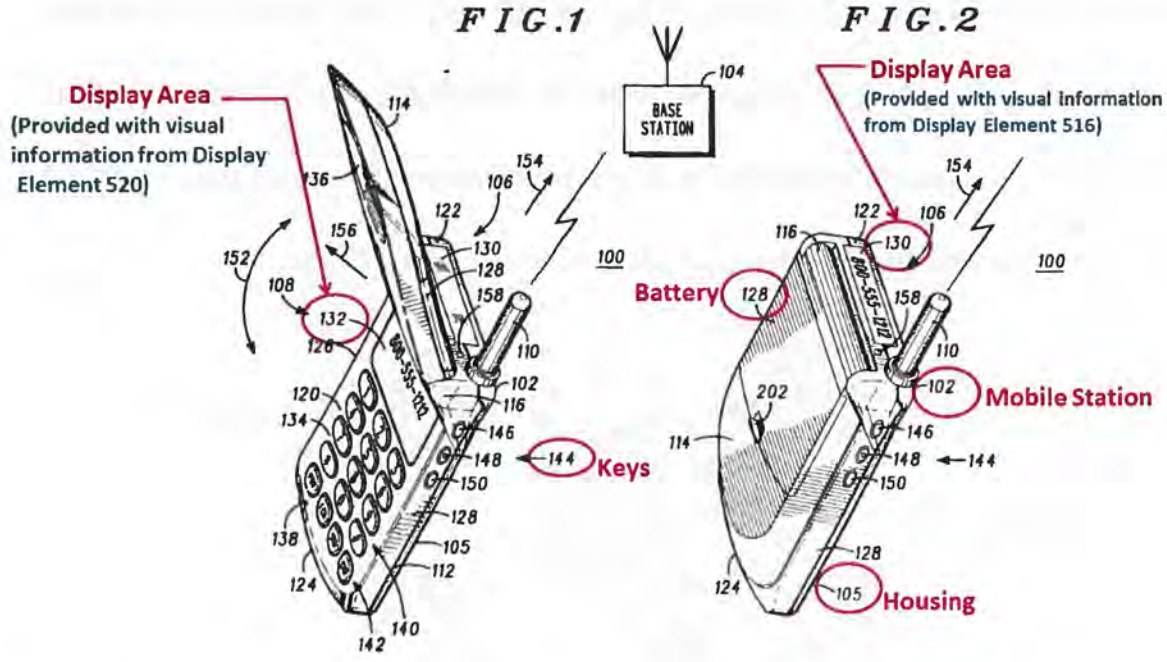


34. Jahagirdar also disclosed that its indicator (display element 516) was active when the load (display element 520) was not activated by the user. *Id.* at col. 5 ll. 35-37. Specifically, in relation again to Figure 8A, above, Jahagirdar

disclosed that prior to the key actuation detection (step 814) and the step of displaying a visible indicator (step 816), display element 520 was turned off at step 806. *See id.* Jahagirdar described that "[i]f power was previously enabled for driver 518 and display element 520, controller 504 disables power thereto (step 806)." *Id.* Because the load (display element 520) was already off at step 806, the indicator could be active when the load was not activated by the user. Further, Jahagirdar's controller 504 at least partially implemented the plurality of keys 144: "key circuit 513 provides signals to controller [504] in response to actuations of the plurality of keys 144." *Id.* at col. 4 ll. 19-20.

35. Additionally, Jahagirdar disclosed that its user interface had an automatic delayed deactivation of a function a predetermined period after the function was activated with an activation command received from its keys. With reference again to Figure 8A above, after "controller 504 sends display data to driver 514, which sends display data to display element 516" at step 816, "[c]ontroller 504 sets a timer related to the new display information (step 818)" in order to automatically deactivate the visible indicator, display element 516, a predetermined period of time after it was activated. *Id.* at col. 5 ll. 55-65. Jahagirdar also disclosed that its visible indicator (display element 516), in response to the controller 504 receiving a signal, could be activated to indicate conditions of the product. *Id.* at col. 5 ll. 59-61. The visible indicator showed a

state of the product or a condition of the product. For example, Jahagirdar described that display element 516 displayed visual information such as "status information, and may include date and time information, battery status information such as a battery level indication and/or a low battery warning indication." *Id.* at col. 5 ll. 59-61. This status information showed a state or condition of the product. Also, with reference to Figures 1 and 2 below, Jahagirdar disclosed that keys 144 were integral with housing 105. *Id.* at col. 2 l. 13, figs. 1-2.



VIII. Obviousness – Description of Prior-Art Touch Sensor References

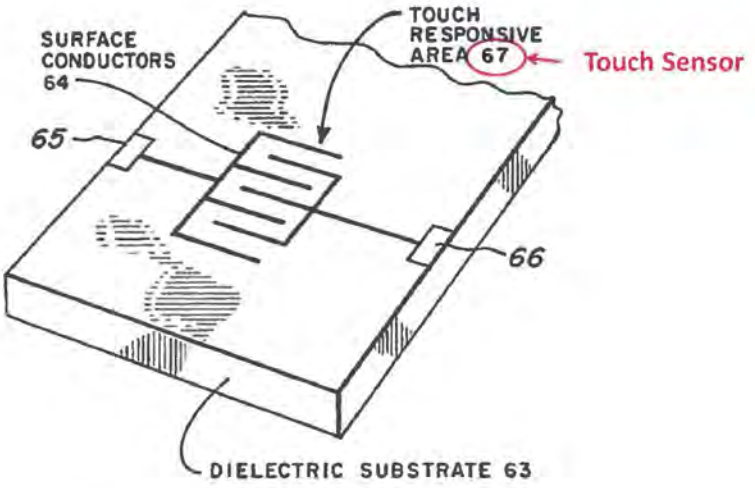
A. Schultz

36. Schultz is a U.S. patent entitled "Touch Actuated System Responsive to a Combination of Resistance and Capacitance." Ex. 1005 (Schultz) at [54]. It

issued on October 11, 1977. *Id.* at [45]. I understand that Schultz is prior art to the '749 patent. As is the case with the '749 patent and Jahagirdar, Schultz was directed to the field of electronic circuitry applied to MMIs, and in particular, Schultz described "a reliable touch actuated system." *Id.* at col. 1 ll. 27-31.

37. With reference to Figure 3 from Schultz, reprinted below, Schultz described a touch sensor type switch that included a sense pad: touch responsive area 67. *Id.* at col. 4 ll. 47-48. When "an element, such as the human finger, across the conductors 34 and 35 [corresponding to touch responsive area 67] causes the voltage on conductor 36 to change state and be inverted by the inverter 41[, t]his inversion by inverter 41 combined with the pulse output 11 causes the flip-flop 43 to change state and activate the load 52." *Id.* at col. 4 ll. 30-35.

FIG. 3



38. Schultz further described that its design was an improvement over prior-art switches because it minimized inadvertent actuation. *Id.* at col. 1 ll. 20-

21. "With the present system, a more reliable touch sensing mechanism is provided than is available by mere capacitive proximity type touch devices or purely resistive touch type devices." *Id.* at col. 1 ll. 64-67. Specifically, "[t]he mere application of a short circuit between the conductors 34 and 35 does not provide the necessary charging delay of capacitor 60 and voltage which are necessary to actuate the present system. The inherent body capacitance 60 of an animal is required." *Id.* at col. 4 ll. 35-40. I note that Schultz included humans among the "animals" that could interact with the sensor: "[t]here are numerous types of electrical control systems that are responsive to the touch of animals, such as humans, pets or domestic animals." *Id.* at col. 1 ll. 7-9.

39. Schultz described that its touch sensor had an advantage over "[c]onventional electric switches which require movements [and] are susceptible to contamination and mechanical failures." *Id.* at col. 1 ll. 17-19. Schultz further explained that its touch sensor "has no moving parts and is therefor not subject to...contamination and spurious types of operation." *Id.* at col. 1 l. 68-col. 2 l. 1.

B. Touch Sensors in the Prior Art Generally

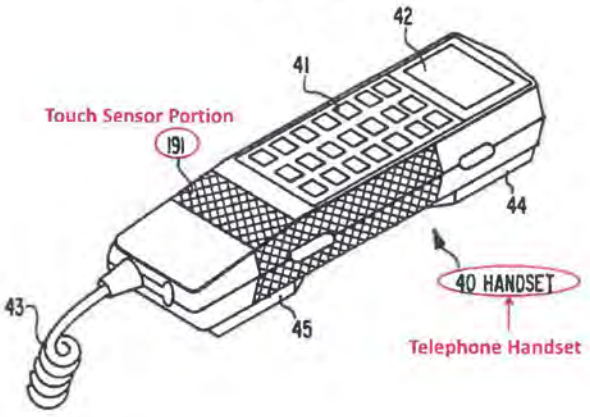
40. By 1998, touch sensing was old technology with widely recognized functionality. Touch sensors similar to those described in Schultz also had known applications in telephones, such as Jahagirdar's mobile phone.

41. For example, Norimatsu, a U.S. patent entitled "Telephone Having

Touch Sensor for Responding to a Call," issued on July 12, 1994. Ex. 1006 (Norimatsu) at [45], [54]. Figure 4 of Norimatsu, shown below, depicted a telephone handset 40 that included a touch sensor portion 191. *Id.* at col. 4 l. 1.

42. Norimatsu described that "[t]he sensor portion, or mesh, 191 is attached to part of the handset surface, which part is so selected that the user can most conveniently touch thereon." *Id.* at col. 4 ll. 9-12. Further, "when the user touches the sensor portion 191, the amplifier 194 produces a high-level signal which is sent to the controller 15 as a detection signal." *Id.* at col. 3 ll. 61-63. "[I]n response to the detection signal, the controller 15 determines that the user has responded to a call and then stops the transmission of the signaling tone." *Id.* at col. 3 ll. 65-68.

FIG. 4



43. Norimatsu described the convenience of such touch sensors for the user: "[a]nother object of the present invention is to provide a telephone in which

the user can easily respond to a call by simply touching the telephone." *Id.* at col. 1 ll. 34-36.

44. Other benefits of touch sensing had long been recognized in the field. For example, in the 1985 publication of "Issues and Techniques in Touch-Sensitive Tablet Input," written by William Buxton et al., the authors highlighted that the "simple construction, [of touch sensors] with no moving parts, leads to reliable and long-lived operation." Ex. 1007 (Buxton) at p. 216.

45. Further, references which were cited in the prosecution of the '749 patent provided similar indications of the benefits of touch sensing. For example, DePauli, which was entitled "Delayed Response Touch Switch Controller" and issued on October 16, 1990, described that "[t]ouch control switching systems, especially for controlling illumination devices, have proven appealing due to their added convenience and aesthetics." Ex. 1008 (DePauli) at [45], [54], col. 1 ll. 22-24.

46. Further, Roudeski, which was entitled "Touch Control Lamp Socket Interior" and issued on August 16, 1988, taught that "[t]ouch controls are quick and convenient, and especially ideal for pre-schoolers and physically disabled persons, such as arthritics, who find it difficult, in view of their limited dexterity, to operate conventional light switches." Ex. 1009 (Roudeski) at [45], [54], col. 1 ll. 16-20.

IX. Summary of Obviousness Opinions

47. For the reasons expressed throughout this declaration, it is my opinion that the limitations of the Challenged Claims can be found in Jahagirdar and in the touch sensor prior art, for example in Schultz. And as I explain, it would have been obvious to a person of ordinary skill in the art at the time of the invention to combine Jahagirdar and Schultz to reach the combinations recited in the Challenged Claims. Specifically, by 1998, a person of ordinary skill in the art would have been familiar with the distinction between push buttons and physical-touch sensors, and would have understood that a physical-touch sensor would be useful in place of a push button type switch. Further, a person of ordinary skill would have understood that touch sensor switches avoid problems of mechanical switches such as wear, accumulation of dirt or grease, and the like, especially in outdoor environments where exposure to dust and dirt would have been common. Additionally, touch sensor switches had aesthetic advantages and also provided for a quick and convenient user interface.

48. Attachment A includes a claim chart which provides a helpful summary of my opinions explained in detail below.

X. Independent Claim 1 would have been obvious over Jahagirdar in combination with Schultz

A. Jahagirdar taught the limitations of claim 1's preamble, "An electronic unit for use with a product comprising connections for a power source and at least one energy consuming load, said unit comprising:"

49. Claim 1 begins as follows: "An electronic unit for use with a product comprising connections for a power source and at least one energy consuming load, said unit comprising." Jahagirdar described this limitation.

50. Referring to Figure 5, as well as Figures 1 and 2, all below, Jahagirdar disclosed an electronic unit (electrical circuitry 500) for use with a product: mobile station 102 (a portable communication device). Ex. 1004 (Jahagirdar) at col. 1 l. 63-col. 2 l. 6, col. 3 ll. 30-31, figs. 1-2.

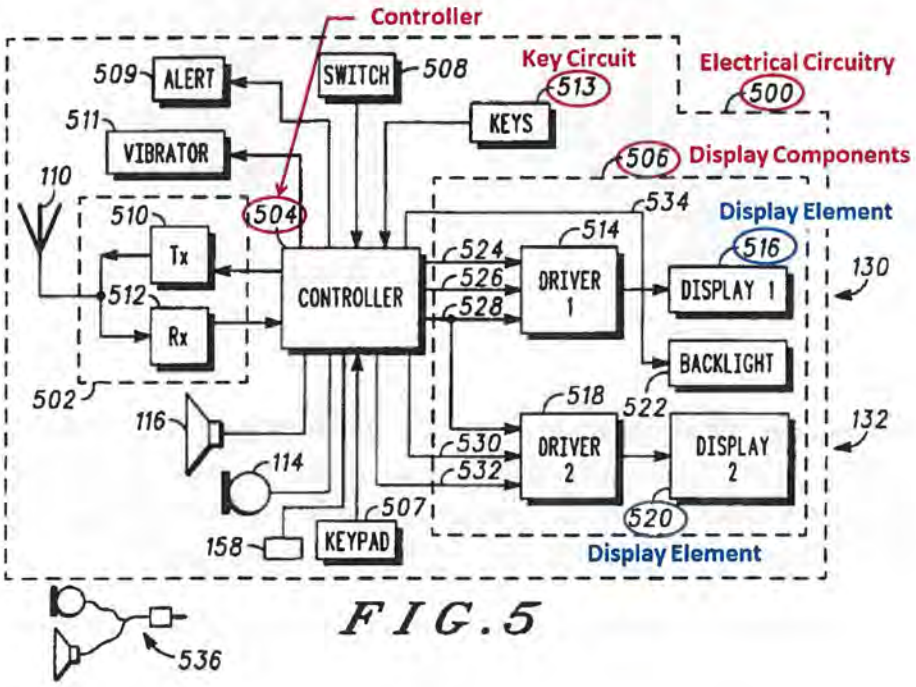
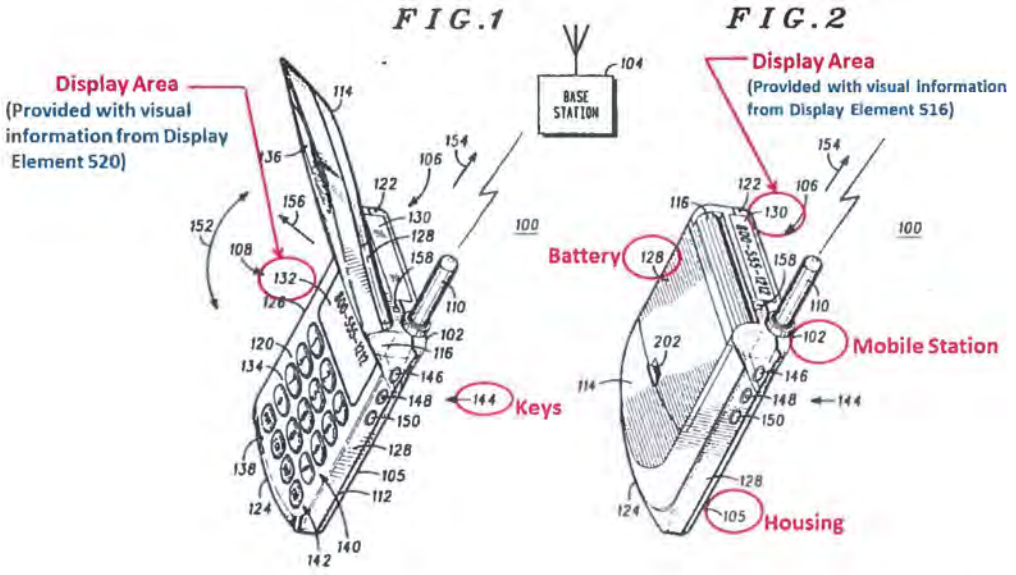


FIG. 5

51. Electrical circuitry 500 included a connection for a power source, such as battery 128: "[m]obile station 102 also includes a removable battery 128." *Id.* at col. 3 l. 33. Electrical circuitry 500 also included a connection for at least one energy consuming load (display element 520). *Id.* at col. 4 ll. 27-30. As shown in Figures 1 and 2 below, the energy consuming load (display element 520) provided visual information in display area 132: "[d]isplay elements 516 and 520 provide visual information in display areas 130 and 132, respectively." *Id.* at col. 4 ll. 40-41.



B. Recitation [a] of claim 1: Jahagirdar combined with Schultz renders obvious "a microchip connected to a user interface switch structure, said structure comprising at least one switch, being a touch sensor type switch that includes a sense pad"

52. The next part of claim 1 (recitation [a]) reads "(a) a microchip connected to a user interface switch structure, said structure comprising at least one

switch, being a touch sensor type switch that includes a sense pad;" Jahagirdar in combination with Schultz renders obvious recitation [a].

53. Referring below to Figure 5 from Jahagirdar, electrical circuitry 500 included a microchip (controller 504) and an electronic circuit (key circuit 513). Jahagirdar's "[e]lectrical circuitry 500 includes . . . a key circuit 513." Ex. 1004 (Jahagirdar) at col. 3 ll. 60-67. Also, Jahagirdar explained that "controller 504 . . . is disposed in housing portion 112 on a printed circuit board (PCB)." *Id.*

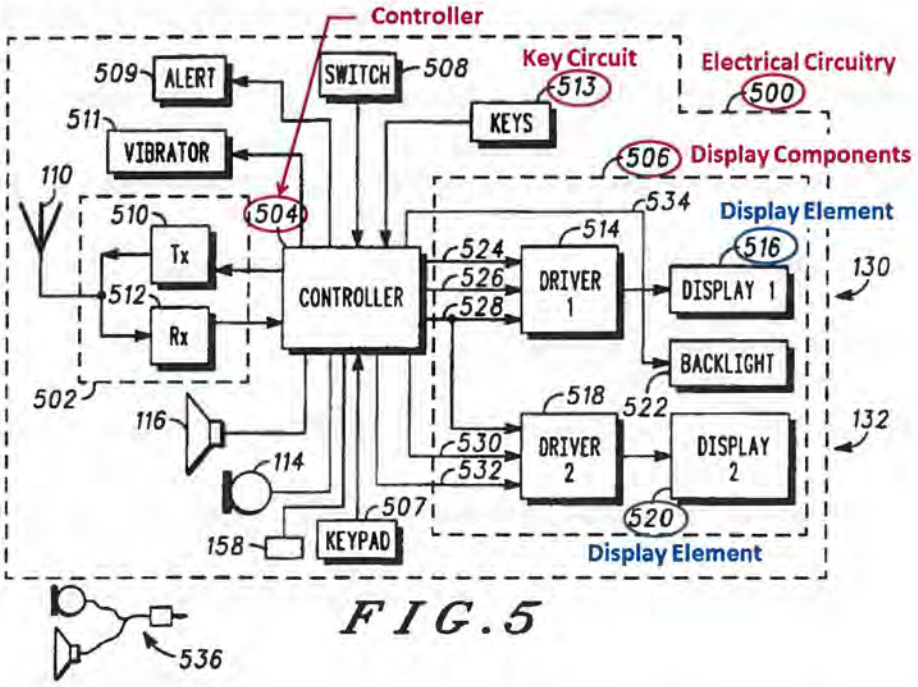


FIG. 5

54. Additionally, Jahagirdar's "key circuit 513 provides signals to controller [504] in response to actuations of the plurality of keys 144." *Id.* at col. 4 ll. 19-20. Jahagirdar's user interface switch structure included the key circuit 513

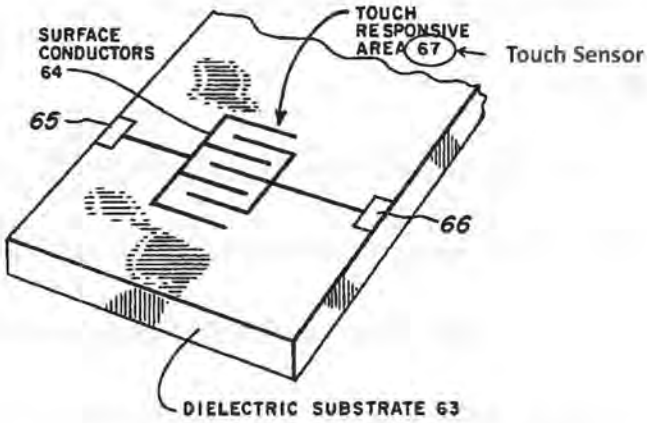
and the plurality of keys 144 (*i.e.*, the at least one switch). *Id.* at col. 3 ll. 30-31. Referring to Figures 1 and 2, shown above, keys 144 were located on the outer housing of the mobile station 102 and could be used to control various functions of the mobile station 102 such as answering or terminating a call, forwarding a call to voicemail, or displaying information on one of the display areas. *Id.* at col. 6 ll. 40-45, col. 7 ll. 5-11, col. 7 ll. 16-20.

55. Jahagirdar did not disclose that any of keys 144 were touch sensor type switches. However, touch sensors were well known in the art by the claimed priority date of the '749 patent. Based on this knowledge, one of ordinary skill in the art as of 1998 would have sought to incorporate touch sensors into the plurality of keys 144, so as to form a user-interface switch structure comprising a touch-sensor type switch that included a sense pad.

56. In that regard, Schultz disclosed "a reliable touch actuated system . . . responsive to the touch of an animal...[such as] human beings, pets and domestic animals." Ex. 1005 (Schultz) at col. 1 ll. 27-31. Specifically, with reference to Figure 3 shown below, Schultz disclosed a touch sensor type switch having a sense pad (touch responsive area 67). *Id.* at col. 4 ll. 46-47. When "an element, such as the human finger, across the conductors 34 and 35 [corresponding to touch responsive area 67] causes the voltage on conductor 36 to change state and be inverted by the inverter 41[, t]his inversion by inverter 41 combined with the pulse

output 11 causes the flip-flop 43 to change state and activate the load 52." *Id.* at col. 4 ll. 30-35.

FIG. 3



57. Schultz further described that its design was an improvement over the prior art because it minimized inadvertent actuation. *Id.* at col. 1 ll. 20-21. "With the present system, a more reliable touch sensing mechanism is provided than is available by mere capacitive proximity type touch devices or purely resistive touch type devices." *Id.* at col. 1 ll. 64-67. Specifically, "[t]he mere application of a short circuit between the conductors 34 and 35 does not provide the necessary charging delay of capacitor 60 and voltage which are necessary to actuate the present system. The inherent body capacitance 60 of an animal is required." *Id.* at col. 4 ll. 35-40. In other words, both physical contact and capacitance were required to actuate the switch disclosed in Schultz. *See id.*

58. One of ordinary skill in the art would have been motivated to combine the features of Schultz with the method and system of Jahagirdar to arrive at claim

1 of the '749 patent, for at least a few reasons: (1) to minimize accidental actuation; (2) to eliminate the problems of contamination and mechanical failures associated with switches having moving parts; and (3) to enhance convenience and aesthetics for the user.

59. Incorporating a touch sensor into Jahagirdar would have asked little of a person of ordinary skill, because a touch sensor would have improved Jahagirdar in the same way that a touch sensor would have improved any such electronic device. This is a strong indication that combining the device disclosed in Jahagirdar with a touch sensor would have been an obvious step. Schultz described that its touch sensor was more reliable than prior-art capacitive and resistive types of sensors, because both physical contact and capacitance were required to actuate the switch. *Id.* at col. 1 ll. 64-67, col. 4 ll. 35-40. For this reason, one of ordinary skill in the art would have recognized that Schultz's touch sensor would have improved the mobile station of Jahagirdar. Because Schultz's touch sensor required inherent body capacitance to be actuated, one of ordinary skill would have sought to incorporate Schultz's touch sensors into Jahagirdar's keys in order to avoid accidental actuations.

60. Specifically, without incorporation of Schultz's touch sensors, Jahagirdar's keys could have been actuated merely by the phone making contact with another object, but not necessarily the user's finger. For example, if the

phone was in the user's pocket, and the user bumped into something, keys 144 could inadvertently be actuated. Schultz's touch sensor avoided this issue by requiring inherent body capacitance to be present in order to actuate. Accordingly, because providing a touch sensor to the mobile station of Jahagirdar would not have been beyond the capability and knowledge of a person of ordinary skill in the art, it would have been obvious to incorporate touch sensors into Jahagirdar's keys 144 in order to avoid accidental actuations.

61. Schultz also described that its touch sensor had an advantage over mechanical switches "[c]onventional electric switches which require movements [and] are susceptible to contamination and mechanical failures." Ex. 1005 (Schultz) at col. 1 ll. 17-19. Schultz explained that its touch sensor "has no moving parts and is therefor [sic] not subject to... contamination and spurious types of operation." *Id.* at col. 1 l. 67-col. 2 l. 1. One of ordinary skill in the art would have recognized that Schultz's features would thusly have improved the mobile station of Jahagirdar. Since providing a touch sensor to the mobile station of Jahagirdar would have been well within the capability of one of ordinary skill, because it would have provided readily apparent benefits, it would have been obvious to incorporate touch sensors into Jahagirdar's keys 144 in order to eliminate the problems of contamination and mechanical failures that were associated with switches having moving parts, such as keys 144. I note that

Buxton (Ex. 1007) explained that touch sensors were advantageous in this way: "simple construction, with no moving parts, leads to reliable and long-lived operation." Ex. 1007 (Buxton) at p. 216.

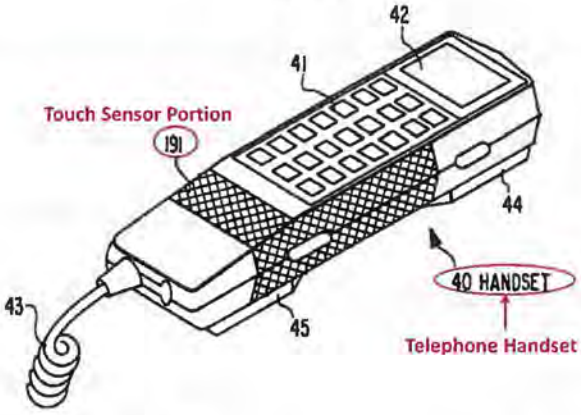
62. Avoiding issues of contamination and mechanical failure would have been especially important for portable devices, such as Jahagirdar's mobile phone, because mobile phones would commonly have been used in environments, such as the outdoors, where exposure to dust and dirt would have been common. Also, mobile phones were often put in a user's pocket, as they are today. Furthermore, buttons on a mobile phone such as Jahagirdar's would have been pressed repeatedly for years, and there would have been an incentive to minimize mechanical failure.

63. Still further, touch sensors such as those described in Schultz would have enhanced the convenience and aesthetics of the device described in Jahagirdar. For example, in relation to its telephone, Norimatsu described that incorporation of a touch sensor into a telephone provided convenience to the user: "[a]nother object of the present invention is to provide a telephone in which the user can easily respond to a call by simply touching the telephone." Ex. 1006 (Norimatsu) at col. 1 ll. 35-37.

64. Specifically, with reference to the Figure 4 shown below, Norimatsu described a telephone handset 40 that included a touch sensor portion 191. *Id.* at

col. 4 ll. 1-2. Norimatsu described that "[t]he sensor portion, or mesh, 191 is attached to part of the handset surface, which part is so selected that the user can most conveniently touch thereon." *Id.* at col. 4 ll. 9-12. Further, "when the user touches the sensor portion 191, the amplifier 194 produces a high-level signal which is sent to the controller 15 as a detection signal." *Id.* at col. 3 ll. 61-63. "[I]n response to the detection signal, the controller 15 determines that the user has responded to a call and then stops the transmission of the signaling tone." *Id.* at col. 3 ll. 65-68.

FIG. 4



65. In another example, DePauli described that "[t]ouch control switching systems, especially for controlling illumination devices, have proven appealing due to their added convenience and aesthetics." Ex. 1008 (DePauli) at col. 1 ll. 22-24. Similarly, Roudeski taught that "[t]ouch controls are quick and convenient, and especially ideal for pre-schoolers and physically disabled persons, such as

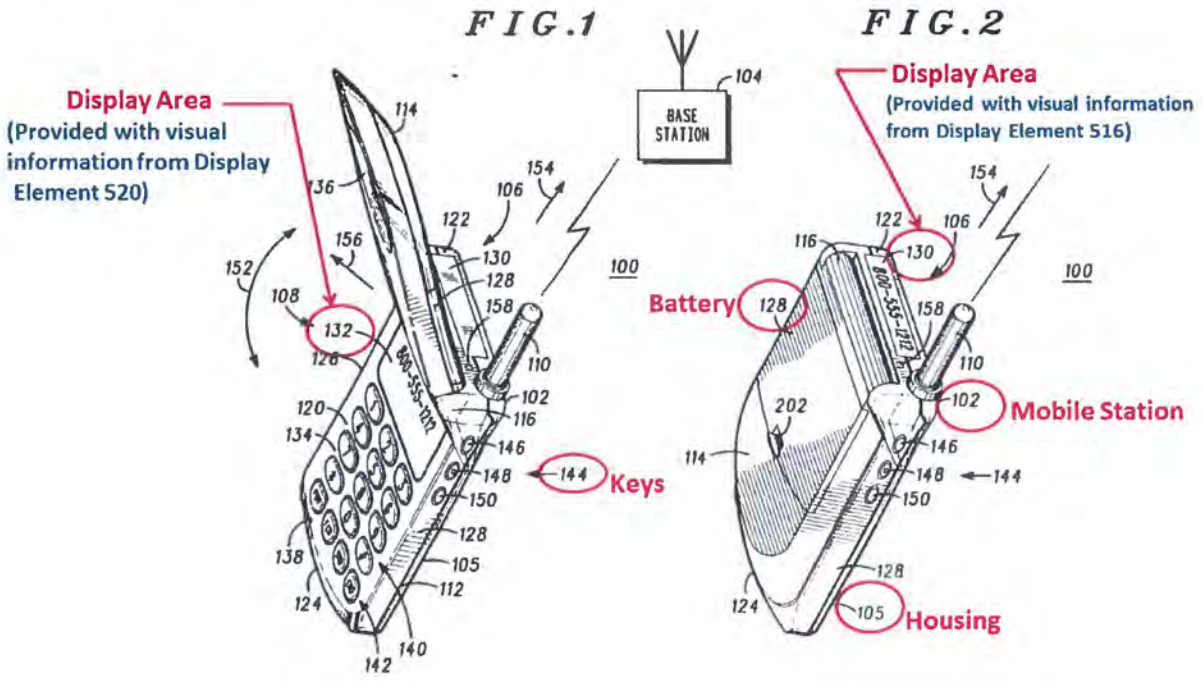
arthritics, who find it difficult, in view of their limited dexterity, to operate conventional light switches." Ex. 1009 (Roudeski) at col. 1 ll. 16-20.

66. The proposed combination of the device disclosed in Jahagirdar with one or more touch sensors is a very good example of arranging old elements wherein each performs the same function that it had been known to perform, yielding no more than one would expect, and thus very predictable results. Further, although the claim does not specify the details of the claimed touch sensor, it is worth noting that Schultz's touch sensor could have been integrated into Jahagirdar's keys 144 in multiple ways depending upon what might have been convenient or desirable. For example, Jahagirdar's keys 144 could have been replaced in their entirety by one, two, three, or more touch sensors. The functions performed by keys 144 could instead be performed by a different number of touch sensors, such as one or two touch sensors. These various configurations would have been trivial adjustments for one of skill in the art, as illustrated, for example, by Buxton (Ex. 1007). Buxton described that a single touch sensor could be used to provide multiple units of input: "Given a large enough surface of the appropriate technology, one could use all fingers of both hands simultaneously, thus providing ten separate units of input." Ex. 1007 (Buxton) at p. 218. Buxton analogized such a touch sensor to a piano: "As playing the piano illustrates, there are some contexts where we might want to use several, or even all [inputs], at once." *Id.* Also, while

not ideal, Buxton further elaborated that "multiple taps or timing cues for signalling [sic] could be tried." *Id.* at p. 220. Additionally, although the claim does not specify the location(s) of the claimed touch sensor(s), again I note that if Jahagirdar's keys 144 were replaced with multiple touch sensors, a person of ordinary skill would have been readily able to relocate those touch sensors to different locations relative to the original positions of keys 144 so as to provide for readily identifiable distinction in location. Furthermore, one of skill could have easily programmed Jahagirdar's controller such that touch sensor inputs are only recognized at appropriate times for example, depending on whether the mobile station 102 is opened or closed. All of these various permutations would have been known options well within the technical grasp of a person of ordinary skill at the time. Indeed, having all of these different options readily available would have made adding touch sensors to Jahagirdar even more desirable to a person of skill in the art. All of these are other strong indicators of obviousness. Here, Jahagirdar and Schultz demonstrated that the elements of claim 1 were well known, and the combination of the techniques described therein would have yielded no more than one would have expected from such an arrangement. These facts further support my opinion that the subject matter of claim 1 would have been obvious as of 1998.

C. Recitation [b] of claim 1: Jahagirdar taught "visible indicator… [that provided] an indicator activation function when a signal is received through said user interface switch, wherein the indicator is active when the load is not activated by the user"

67. The next part of claim 1 (recitation [b]) reads as follows: "(b) a visible indicator controlled by the microchip to provide at least an indicator activation function when a signal is received through said user interface switch, wherein the indicator is active when the load is not activated by the user;" Jahagirdar taught all the elements of recitation [b].



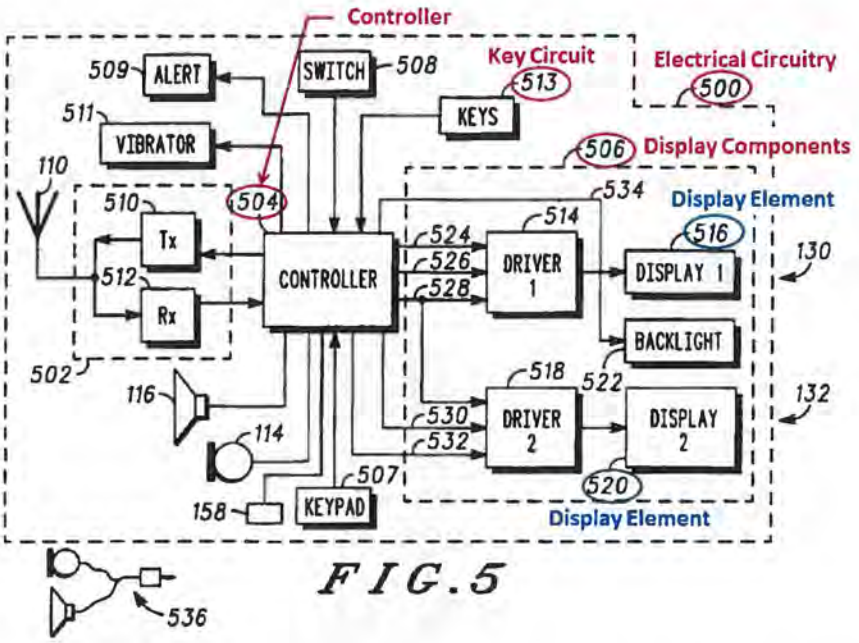
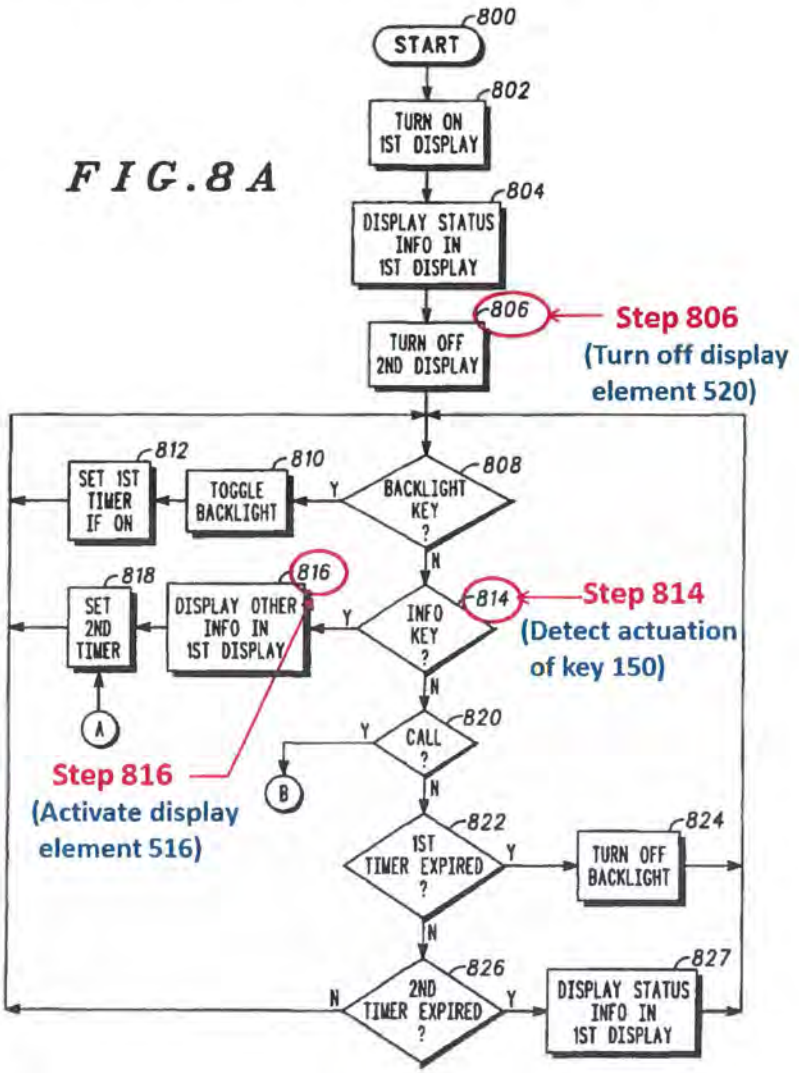


FIG. 5

68. Referring again to Figure 5 above, the electrical circuitry 500 of mobile station 102 included display components 506 such as the load (display element 520) and also a visible indicator (display element 516). Ex. 1004 (Jahagirdar) at col. 3 ll. 60-62, col. 4 ll. 27-30. And referring again to Figures 1 and 2 above, "[d]isplay elements 516 and 520 provide visual information in display areas 130 and 132, respectively." *Id.* at col. 4 ll. 40-41. Jahagirdar's display element 516 could provide an indicator activation function such as displaying visual information in display area 130. *See id.* at col. 5 ll. 54-57. Additionally, Jahagirdar's display element 516 was controlled by the microchip to provide its indicator activation function when a signal was received from key 150 (of the plurality of keys 144 which were part of Jahagirdar's user interface switch). *Id.* at

col. 5 ll. 54-65. Referring to Figure 8A, shown below, Jahagirdar disclosed "[i]f controller 504 detects an actuation of key 150 (step 814), controller 504 sends display data to driver 514, which sends display data to display element 516. For [sic] displaying new visual information in display area 130." *Id.* at col. 5 ll. 54-57.

FIG. 8A



69. Jahagirdar's indicator (display element 516) was active when its load (display element 520) was not activated by the user. *See id.* at col. 5 ll. 35-37.

Referring again to Figure 8A, above, Jahagirdar disclosed that prior to the key actuation detection (step 814) and the step of displaying a visible indicator (step 816), display element 520 was turned off at step 806. *See id.* Jahagirdar described that "[i]f power was previously enabled for driver 518 and display element 520, controller 504 disables power thereto (step 806)." *Id.* Jahagirdar described that because the load, display element 520, was already off at step 806, the indicator could be active when the load was not activated by the user. *See id.*

D. Recitation [c] of claim 1: Jahagirdar taught the microchip… implement[ing] the touch sensor … and …automatic delayed deactivation…indicat[ing] conditions of the product… [or] a touch sensor…[that is] integral"

70. The last part of claim 1 (recitation [c]) reads as follows: "(c) wherein the microchip at least partially implements the touch sensor switch and the user interface has at least one of: (i) an automatic delayed deactivation of a function a predetermined period after the function was activated with an activation command received from the touch sensor switch; (ii) the indicator, in response to the microchip receiving a user interface switch signal, activated to indicate conditions of the product; and (iii) a touch sensor switch sense pad being integral with a housing of the product." Jahagirdar taught all the elements of recitation [c].

71. As I described in relation to recitation [a], Jahagirdar's controller 504 at least partially implements the plurality of keys 144: "key circuit 513 provides

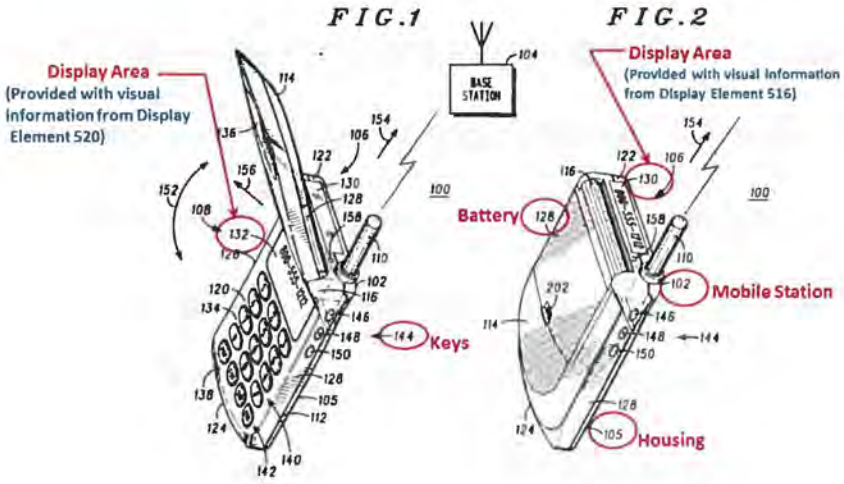
signals to controller [504] in response to actuations of the plurality of keys 144." Ex. 1004 (Jahagirdar) at col. 4 ll. 19-20. Further, as I described above, touch sensors were well known in the art by the priority date of the '749 patent. Based on known teachings, and referring to the reasons described in Recitation [a], one of ordinary skill in the art as of 1998 would have sought to incorporate touch sensors into the plurality of keys 144 such that the microchip (controller 504) at least partially implemented the touch sensor switch.

72. Further, Jahagirdar's user interface had an automatic delayed deactivation of a function that occurred a predetermined period after the function was activated with an activation command received from its keys. Referring again to Figure 8A above, after "controller 504 sends display data to driver 514, which sends display data to display element 516" at step 816, "[c]ontroller 504 sets a timer related to the new display information (step 818)" in order to automatically deactivate the visible indicator, display element 516, a predetermined period of time after it was activated. *Id.* at col. 5 ll. 55-65. As already described above, one of ordinary skill in the art as of 1998 would have sought to incorporate touch sensors into the keys. Accordingly, Jahagirdar, as modified by Schultz, would have been capable of activating a function in response to an activation command received from the claimed touch sensor switch.

73. Further, Jahagirdar's visible indicator (display element 516), in

response to the controller 504 receiving a switch signal from the user interface, could be activated to indicate conditions of the product. Ex. 1004 (Jahagirdar) at col. 5 ll. 59-61. Jahagirdar also disclosed that its visible indicator showed a state of the product or a condition of the product. *Id.* In one example, Jahagirdar described that display element 516 displayed visual information such as "status information, and may include date and time information, battery status information such as a battery level indication and/or a low battery warning indication." *Id.* This status information showed a state or condition of the product.

74. Lastly, with reference to Figures 1 and 2 below, Jahagirdar disclosed that keys 144 were integral with housing 105. *Id.* at col. 2 l. 13, figs. 1-2. As already described herein, it would have been obvious to incorporate Schultz's touch sensors into Jahagirdar. Doing so would have resulted in a touch sensor switch sense pad that was integral with the housing 105 of the mobile station 102.



XI. Dependent Claim 2 would have been obvious over Jahagirdar in combination with Schultz

75. Claim 2 depends from claim 1. Thus, my analysis for claim 2 incorporates my entire analysis for claim 1, as set forth above. In addition to what I have explained in that analysis, I note that, Jahagirdar described all of the additional limitations of claim 2, rendering claim 2 obvious. Claim 2 reads: "An electronic unit according to claim 1, wherein the user interface has at least two features selected from the group consisting of: (*i*) an automatic delayed deactivation of a function a predetermined period after the function was activated with an activation command received from the touch sensor switch; (*ii*) the indicator, in response to the microchip receiving a user interface switch signal, activated to indicate conditions of the product; and (*iii*) a touch sensor switch sense pad being integral with a housing of the product."

76. As I already described in relation to claim 1, Jahagirdar's user interface (as modified by Schultz) has all three of (*i*) an automatic delayed deactivation of a function a predetermined period after the function was activated with an activation command received from the touch sensor switch; (*ii*) a visible indicator that, in response to the controller receiving a signal, activated to indicate conditions of the product; and (*iii*) keys 144 that are integral with a housing of the mobile station 102. *See supra* Section X. Accordingly, for all the same reasons

describe above in relation to claim 1, all of the limitations of claim 2 are disclosed.

XII. Dependent Claim 5 would have been obvious over Jahagirdar in combination with Schultz

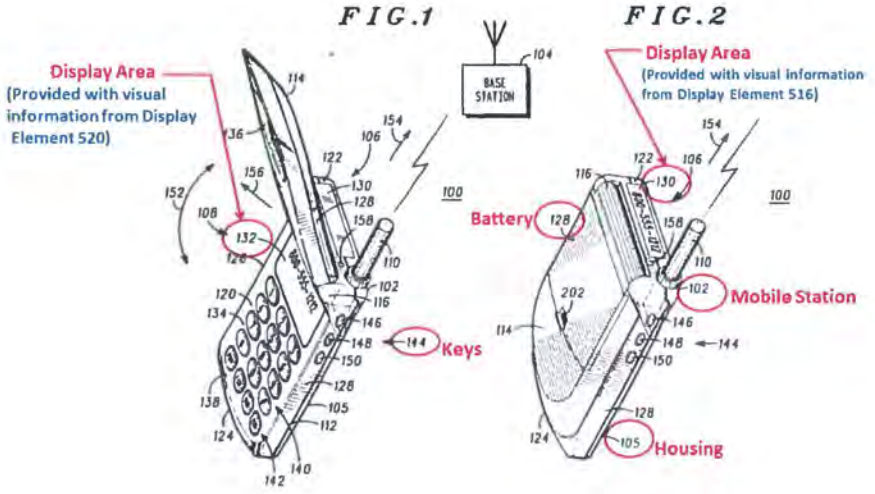
77. Claim 5 depends from claim 1. Thus, my analysis for claim 5 incorporates my entire analysis for claim 1, as set forth above. In addition to what I have explained in that analysis, I note that, Jahagirdar described all of the additional limitations of claim 5, rendering claim 5 obvious. Claim 5 reads: "An electronic unit according to claim 1, wherein the user interface offers at least a feature comprising the indicator, in response to the microchip receiving a user interface switch signal, activated to indicate conditions of the product."

78. As I described above in relation to claim 1, Jahagirdar disclosed a feature including its indicator, which in response to the controller 504 receiving a signal, could be activated to indicate conditions of the product. *See supra* Section X. Jahagirdar's visible indicator (display element 516) showed a state of the product or a condition of the product. *See* Ex. 1004 (Jahagirdar) at col. 5 ll. 59-61. In one example, Jahagirdar described that display element 516 displayed visual information such as "status information, and may include date and time information, battery status information such as a battery level indication and/or a low battery warning indication." *Id.* This status information showed a state or condition of the product.

XIII. Dependent Claim 6 would have been obvious over Jahagirdar in combination with Schultz

79. Claim 6 depends from claim 1. Thus, my analysis for claim 6 incorporates my entire analysis for claim 1, as set forth above. In addition to what I have explained in that analysis, I note that, Jahagirdar described all of the additional limitations of claim 6, rendering claim 6 obvious. Claim 6 reads: "An electronic unit according to claim 1, wherein the user interface offers at least a feature comprising a touch sensor switch sense pad being integral with a housing of the product."

80. As I described above in relation to recitation [c] of claim 1, and referring to Figures 1 and 2 below, Jahagirdar disclosed the feature that keys 144 were integral with housing 105. Ex. 1004 (Jahagirdar) at col. 2 l. 13, figs. 1-2. In this way, Jahagirdar, as modified by Schultz, discloses a touch sensor switch pad that is integral with mobile station 102's housing. *See id.*



XIV. Dependent Claim 7 would have been obvious over Jahagirdar in combination with Schultz

81. Claim 7 depends from claim 1. Thus, my analysis for claim 7 incorporates my entire analysis for claim 1, as set forth above. In addition to what I have explained in that analysis, I note that, Jahagirdar described all of the additional limitations of claim 7, rendering claim 7 obvious. Claim 7 reads: "An electronic unit according to claim 1, wherein the power source is non-mains and the indicator gives at least an indication of a power supply level."

82. As I describe in Section V.A, above, the term "non-mains" would be understood by a person of ordinary skill in the art at the time of the invention to mean "not from the AC utility wiring system of a building."

83. Further, as I indicated above in relation to the preamble of claim 1, Jahagirdar disclosed that its power source was a removable battery 128: "[m]obile station 102 also includes a removable battery 128." Ex. 1004 (Jahagirdar) at col. 3 l. 33. Since a battery is inherently a DC source of power, battery 128, Jahagirdar's power source, would not have been an AC source, and would therefore have been non-mains.

84. Jahagirdar also described that the indicator (display element 516) provided an indication of a power supply level: "battery status information such as a battery level indication and/or a low battery warning indication." *Id.* at col. 5 ll.

60-61.

XV. Dependent Claim 14 would have been obvious over Jahagirdar in combination with Schultz

85. Claim 14 depends from claim 1. Thus, my analysis for claim 14 incorporates my entire analysis for claim 1, as set forth above. In addition to what I have explained in that analysis, I note that, Jahagirdar described all of the additional limitations of claim 14, rendering claim 14 obvious. Claim 14 reads: "An electronic unit according to claim 1, wherein the product comprises RF circuitry and/or audible sound signal generating electronics."

86. Jahagirdar described that its mobile station 102 also uses "radio frequency (RF) signals to provide wireless communications and features such as paging, telephone, and short messaging features." Ex. 1004 (Jahagirdar) at col. 2 ll. 7-10. Referring to the circuitry shown in Figure 5, shown below, Jahagirdar's "[r]eceiver 512 receives RF signals through antenna 110 and demodulates the RF signals." *Id.* at col. 4 ll. 2-4.

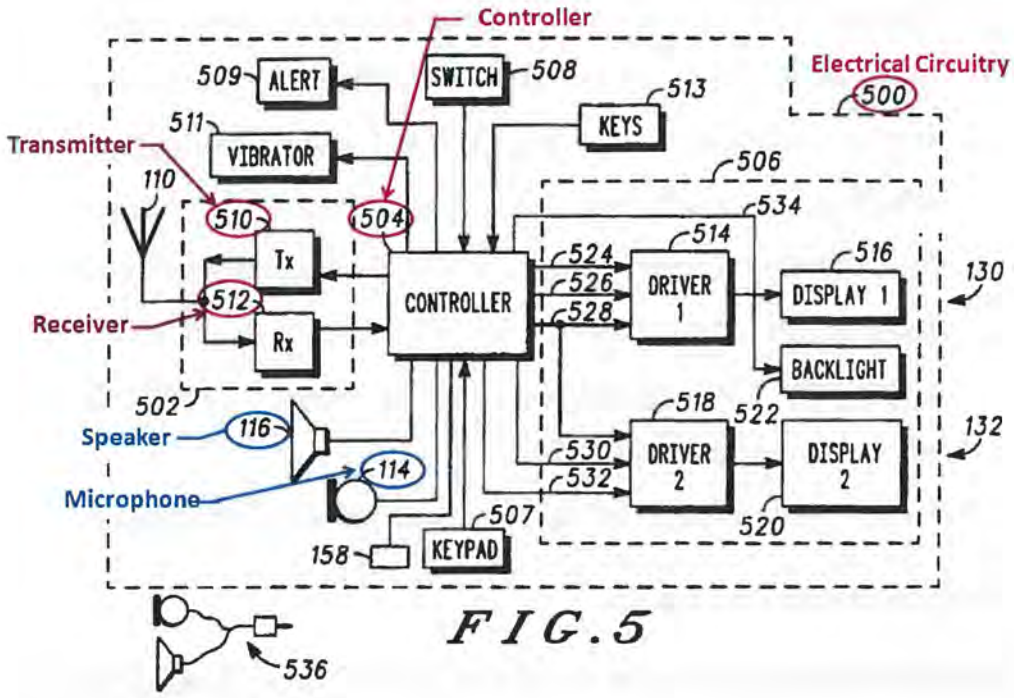


FIG. 5

87. Jahagirdar also disclosed that its product (mobile station 102) includes audible sound signal generating electronics such as a microphone and a speaker: "[e]lectrical circuitry 500 [that] includes . . . microphone 114, and speaker 116." *Id.* at col. 3 ll. 60-64. Jahagirdar's "[m]icrophone 114 and speaker 116 are coupled to controller 504 through audio circuitry (not shown)." *Id.* at col. 4 ll. 11-13. Further, Jahagirdar also indicated that audio signals were generated that passed between receiver 512, speaker 116, microphone 114, and transmitter 510 via controller 504:

> Controller 504 is coupled to and receives the demodulated information from receiver 512. Such information includes control information and may include voice information which is processed and sent to speaker 116. Controller 504 is coupled to transmitter 510 and sends information thereto for transmission. Such information includes control information and may include voice information received from microphone 114.

Id. at col. 4 ll. 4-11. Accordingly, Jahagirdar taught the claimed audible, sound-signal-generating electronics.

XVI. Dependent Claim 15 would have been obvious over Jahagirdar in combination with Schultz

88. Claim 15 depends from claim 1. Thus, my analysis for claim 15 incorporates my entire analysis for claim 1, as set forth above. In addition to what I have explained in that analysis, I note that, Jahagirdar described all of the additional limitations of claim 15, rendering claim 15 obvious. Claim 15 reads: "An electronic unit according to claim 1, wherein power source is a non-mains power source."

89. As I described above in Section V.A, the term "non-mains" would be understood by a person of ordinary skill in the art at the time of the invention to mean "not from the AC utility wiring system of a building," *e.g.*, a battery.

90. Further, as I described above in Section X, Jahagirdar disclosed that

its power source was a removable battery 128: "[m]obile station 102 also includes a removable battery 128." Ex. 1004 (Jahagirdar) at col. 3 l. 33. Since a battery is inherently non-mains, Jahagirdar's power source, battery 128, was non-mains.

XVII. Independent Claim 21 would have been obvious over Jahagirdar in combination with Schultz

A. Jahagirdar taught the limitations of claim 21's preamble, "A method of implementing a user interface for a product comprising connections for a power supply and at least one energy consuming load,"

91. Claim 21 begins "A method of implementing a user interface for a product comprising connections for a power supply and at least one energy consuming load." Jahagirdar described this limitation.

92. Referring to Figures 1, 2, and 5 below, Jahagirdar disclosed a product, mobile station 102 (a portable communication device) that included electrical circuitry 500. Ex. 1004 (Jahagirdar) at col. 1 l. 63-col. 2 l. 6, col. 3 ll. 30-31, figs. 1-2. Jahagirdar also explained that electrical circuitry 500 included a "key circuit 513 [that] provides signals to controller [504] in response to actuations of the plurality of keys 144." *Id.* at col. 4 ll. 19-20. Jahagirdar's user interface included the key circuit 513 and the plurality of keys 144 (*i.e.*, the at least one switch). *Id.* at col. 3 ll. 30-31. Keys 144 were located on the outer housing of the mobile station 102 and could be used to control various functions of the mobile station 102 such as answering or terminating a call, forwarding a call to voicemail, or

displaying information on one of the display areas. *Id.* at col. 6 ll. 40-45, col. 7 ll. 5-11, col. 7 ll. 16-20.

FIG. 1

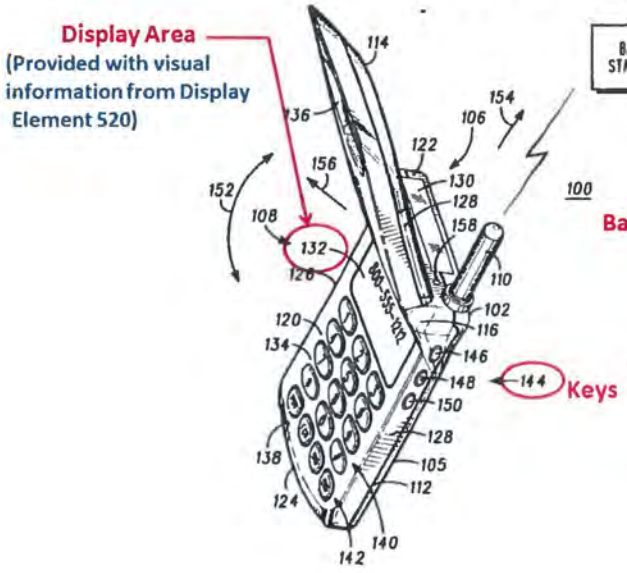
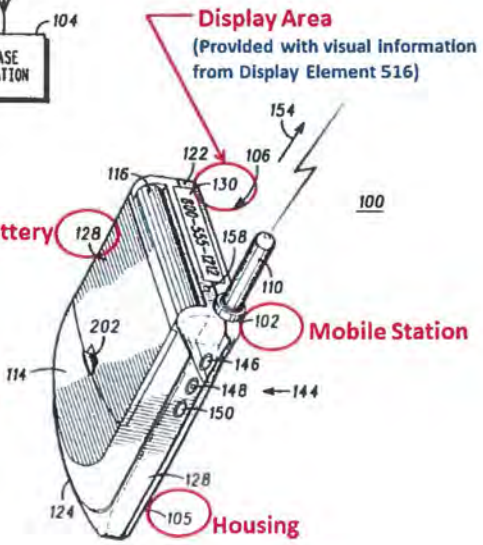


FIG. 2



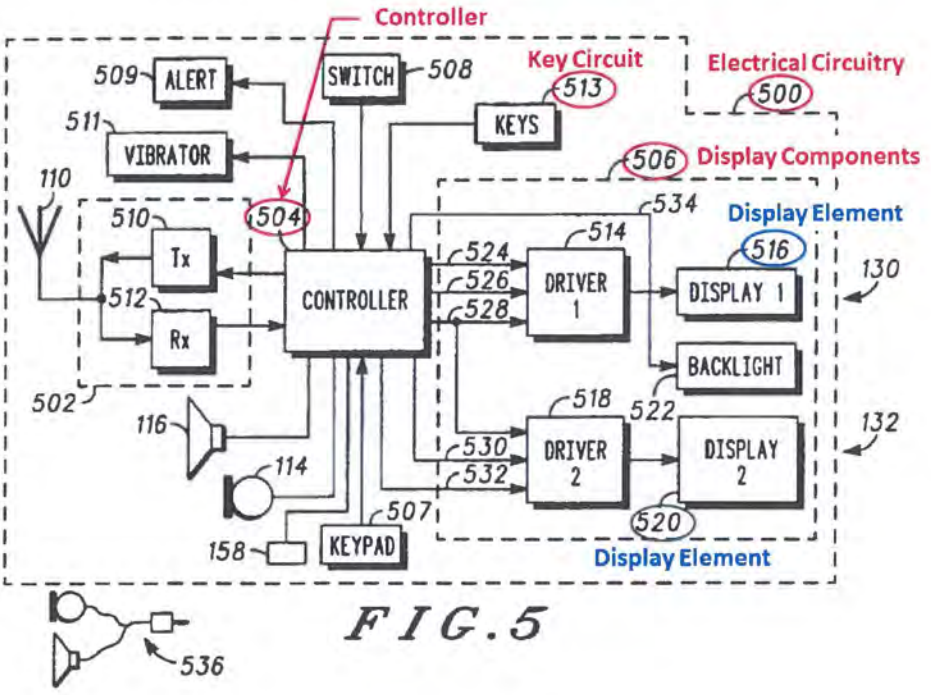


FIG. 5

93. Electrical circuitry 500 included a connection for a power supply, such as battery 128: "[m]obile station 102 also includes a removable battery 128." *Id.* at col. 3 l. 33. Electrical circuitry 500 also included a connection for at least one energy consuming load (display element 520). *Id.* at col. 4 ll. 27-30. Jahagirdar's energy consuming load (display element 520) provided visual information in display area 132: "[d]isplay elements 516 and 520 provide visual information in display areas 130 and 132, respectively." *Id.* at col. 4 ll. 40-41.

B. Limitation [a] of Claim 21: Jahagirdar combined with Schultz renders obvious "using at least a touch sensor user interface switch and a visible indicator,"

94. The next part of claim 21 (limitation [a]) reads: "using at least a touch sensor user interface switch and a visible indicator." Jahagirdar in combination with Schultz renders obvious recitation [a].

95. I have already described how Jahagirdar disclosed a visible indicator: display element 516. With reference again to Figures 1 and 2 above, "[d]isplay elements 516 and 520 provide visual information in display areas 130 and 132, respectively." *Id.* at col. 4 ll. 40-41.

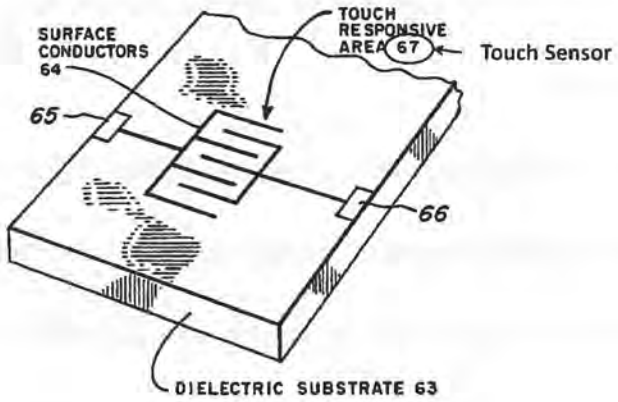
96. Further, as described above, Jahagirdar disclosed the user interface of mobile station 102 that included a plurality of keys 144. *Id.* at col. 3 ll. 30-31, figs. 1-2. Jahagirdar also explained that "[e]lectrical circuitry 500 includes . . . a key circuit 513." *Id.* at col. 3 ll. 60-64. "[K]ey circuit 513 provides signals to

controller [504] in response to actuations of the plurality of keys 144." *Id.* at col. 4 ll. 19-20.

97. Jahagirdar did not disclose that any of the plurality of keys 144 included a touch sensor so as to form a touch sensor user interface switch. However, touch sensors were well known in the art by the priority date of the '749 patent. Based on known teachings, one of ordinary skill in the art as of 1998 would have sought to incorporate touch sensors into keys 144 so as to form a touch sensor user interface capable of being used.

98. In that regard, Schultz described "a reliable touch actuated system . . . responsive to the touch of an animal...[such as] human beings, pets and domestic animals." Ex. 1005 (Schultz) at col. 1 ll. 27-31. Specifically, with reference to Figure 3 shown below, Schultz disclosed a touch sensor user interface switch (touch responsive area 67). *Id.* at col. 4 ll. 46-47. When "an element, such as the human finger, across the conductors 34 and 35 [corresponding to touch responsive area 67] causes the voltage on conductor 36 to change state and be inverted by the inverter 41[, t]his inversion by inverter 41 combined with the pulse output 11 causes the flip-flop 43 to change state and activate the load 52." *Id.* at col. 4 ll. 30-35.

FIG. 3



99. Schultz further described that its design was an improvement over the prior art because it minimized inadvertent actuation. *Id.* at col. 1 ll. 20-21. "With the present system, a more reliable touch sensing mechanism is provided than is available by mere capacitive proximity type touch devices or purely resistive touch type devices." *Id.* at col. 1 ll. 64-67. Specifically, "[t]he mere application of a short circuit between the conductors 34 and 35 does not provide the necessary charging delay of capacitor 60 and voltage which are necessary to actuate the present system. The inherent body capacitance 60 of an animal is required." *Id.* at col. 4 ll. 35-40. In other words, both physical contact and capacitance were required to actuate Schultz's switch. *See id.*

100. One of ordinary skill in the art would have been motivated to combine the features of Schultz with the method and system of Jahagirdar to arrive at claim 21 of the '749 patent for at least a few reasons: (1) to minimize accidental actuation; (2) to eliminate the problems of contamination and mechanical failures

associated with switches having moving parts; and (3) to enhance convenience and aesthetics for the user.

101. Incorporating a touch sensor into Jahagirdar would have asked little of a person of ordinary skill, because a touch sensor would have improved Jahagirdar in the same way that a touch sensor would have improved any such electronic device. This is a strong indication that including a touch sensor would have been an obvious step given the number of available design alternatives. Schultz described that its touch sensor was more reliable than prior-art capacitive- and resistive-type sensors, because both physical contact and capacitance were required to actuate the switch. *Id.* at col. 1 ll. 64-67, col. 4 ll. 35-40. For this reason, one of ordinary skill in the art would have recognized that Schultz's touch sensor would have improved the mobile station of Jahagirdar. Because Schultz's touch sensor required inherent body capacitance to actuate, one of ordinary skill would have sought to incorporate Schultz's touch sensors into Jahagirdar's keys in order to avoid accidental actuations.

102. Specifically, without incorporation of Schultz's touch sensors, Jahagirdar's keys could be actuated merely by the phone making contact with another object, but not necessarily the user's finger. For example, if the phone was in the user's pocket, and the user bumped into something, or sat down in the right orientation, keys 144 could inadvertently be actuated. Schultz's touch sensor

avoided this issue by requiring inherent body capacitance to actuate. Accordingly, because providing a touch sensor to the mobile station of Jahagirdar would have been well within the capabilities of a skilled person, it would have been obvious to incorporate touch sensors into Jahagirdar's keys 144 in order to avoid accidental actuations.

103. Schultz also described that its touch sensor had an advantage over "[c]onventional electric switches which require movements [and] are susceptible to contamination and mechanical failures." Ex. 1005 (Schultz) at col. 1 ll. 17-19. Schultz explained that its touch sensor "has no moving parts and is therefor not subject to...contamination and spurious types of operation." *Id.* at col. 1 l. 67-col. 2 l. 1. One of ordinary skill in the art would have recognized that Schultz's features would have improved the mobile station of Jahagirdar by replacing mechanical keys with touch sensors.

104. Because providing a touch sensor to the mobile station of Jahagirdar would not have been beyond the capabilities of a person of ordinary skill, it would have been obvious to incorporate touch sensors into Jahagirdar's keys 144 in order to eliminate the problems of contamination and mechanical failures that were associated with switches having moving parts, such as the plurality of keys 144. I note that Buxton (Ex. 1007) explained that touch sensors were advantageous in this way: "simple construction, with no moving parts, leads to reliable and long-lived

operation." Ex. 1007 (Buxton) at p. 216.

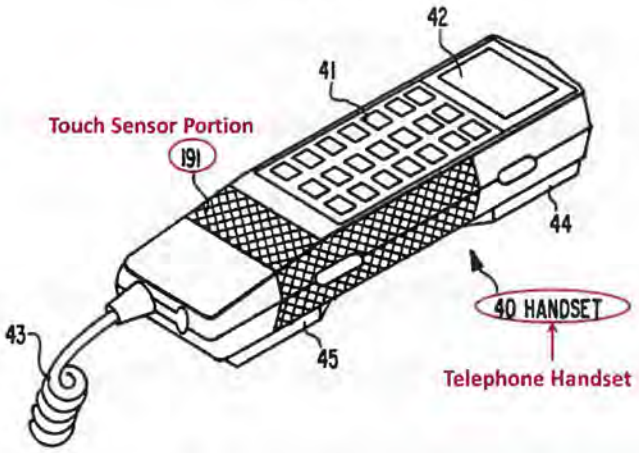
105. Avoiding issues of contamination and mechanical failure would have been especially important for portable devices, such as Jahagirdar's mobile phone, because mobile phones would commonly have been used in environments, such as the outdoors, where exposure to dust and dirt would have been common. Also, mobile phones were often put in a user's pocket, as they are today. Furthermore, buttons on a mobile phone such as Jahagirdar's would have been pressed repeatedly for years, and there would have been an incentive to minimize mechanical failure of the keys.

106. Further, touch sensors such as those described in Schultz would have enhanced the convenience and aesthetics of Jahagirdar. For example, in relation to its telephone, Norimatsu described that incorporation of a touch sensor into a telephone provided convenience to the user: "[a]nother object of the present invention is to provide a telephone in which the user can easily respond to a call by simply touching the telephone." Ex. 1006 (Norimatsu) at col. 1 ll. 34-36. Specifically, with reference to Figure 4 shown below, Norimatsu described a telephone handset 40 that included a touch sensor portion 191. *Id.* at col. 4 l. 1.

107. Norimatsu described that "[t]he sensor portion, or mesh, 191 is attached to part of the handset surface, which part is so selected that the user can most conveniently touch thereon." *Id.* at col. 4 ll. 9-12. Further, "when the user

touches the sensor portion 191, the amplifier 194 produces a high-level signal which is sent to the controller 15 as a detection signal." *Id.* at col. 3 ll. 61-63. "[I]n response to the detection signal, the controller 15 determines that the user has responded to a call and then stops the transmission of the signaling tone." *Id.* at col. 3 ll. 65-68.

FIG. 4



108. In another example, DePauli described that "[t]ouch control switching systems, especially for controlling illumination devices, have proven appealing due to their added convenience and aesthetics." Ex. 1008 (DePauli) at col. 1 ll. 22-24. Further, Roudeski taught that "[t]ouch controls are quick and convenient, and especially ideal for pre-schoolers and physically disabled persons, such as arthritics, who find it difficult, in view of their limited dexterity, to operate conventional light switches." Ex. 1009 (Roudeski) at col. 1 ll. 16-20.

109. The proposed combination of the device disclosed in Jahagirdar with

one or more touch sensors is a very good example of arranging old elements wherein each performs the same function as it had been known to perform, yielding no more than one would expect, and thus producing very predictable results. Further, although the claim does not specify the details of the claimed touch sensor, it is worth noting that Schultz's touch sensor could have been integrated into Jahagirdar's keys 144 in multiple ways depending upon what might have been convenient or desirable. For example, Jahagirdar's keys 144 could have been replaced in their entirety by one, two, three, or more touch sensors. The functions performed by keys 144 could instead be performed by a different number of touch sensors, such as one or two touch sensors. These various configurations would have been trivial adjustments for one of skill in the art, as illustrated, for example, by Buxton (Ex. 1007). Buxton described that a single touch sensor could be used to provide multiple units of input: "Given a large enough surface of the appropriate technology, one could use all fingers of both hands simultaneously, thus providing ten separate units of input." Ex. 1007 (Buxton) at p. 218. Buxton analogized such a touch sensor to a piano "As playing the piano illustrates, there are some contexts where we might want to use several, or even all [inputs], at once." *Id.* Also, while not ideal, Buxton further elaborated that "multiple taps or timing cues for signalling [sic] could be tried." *Id.* at p. 220. Additionally, although the claim does not specify the location(s) of the claimed touch sensor(s),

again I note that if Jahagirdar's keys 144 were replaced with multiple touch sensors, a person of ordinary skill would have been readily able to relocate those touch sensors to different locations relative to the original positions of keys 144 so as to provide for readily identifiable distinction in location. Furthermore, one of skill could have easily programmed Jahagirdar's controller such that touch sensor inputs are only recognized at appropriate times for example, depending on whether the mobile station 102 is opened or closed. All of these various permutations would have been known options well within the technical grasp of a person of ordinary skill at the time. Indeed, having all of these different options readily available would have made adding touch sensors to Jahagirdar even more desirable to a person of skill in the art. All of these are other strong indicators of obviousness. Here, Jahagirdar and Schultz demonstrated that the elements of claim 21 were well known, and the combination of the techniques described therein would have yielded no more than one would expect from such an arrangement. This further supports my opinion that the subject matter of claim 21 would have been obvious as of 1998.

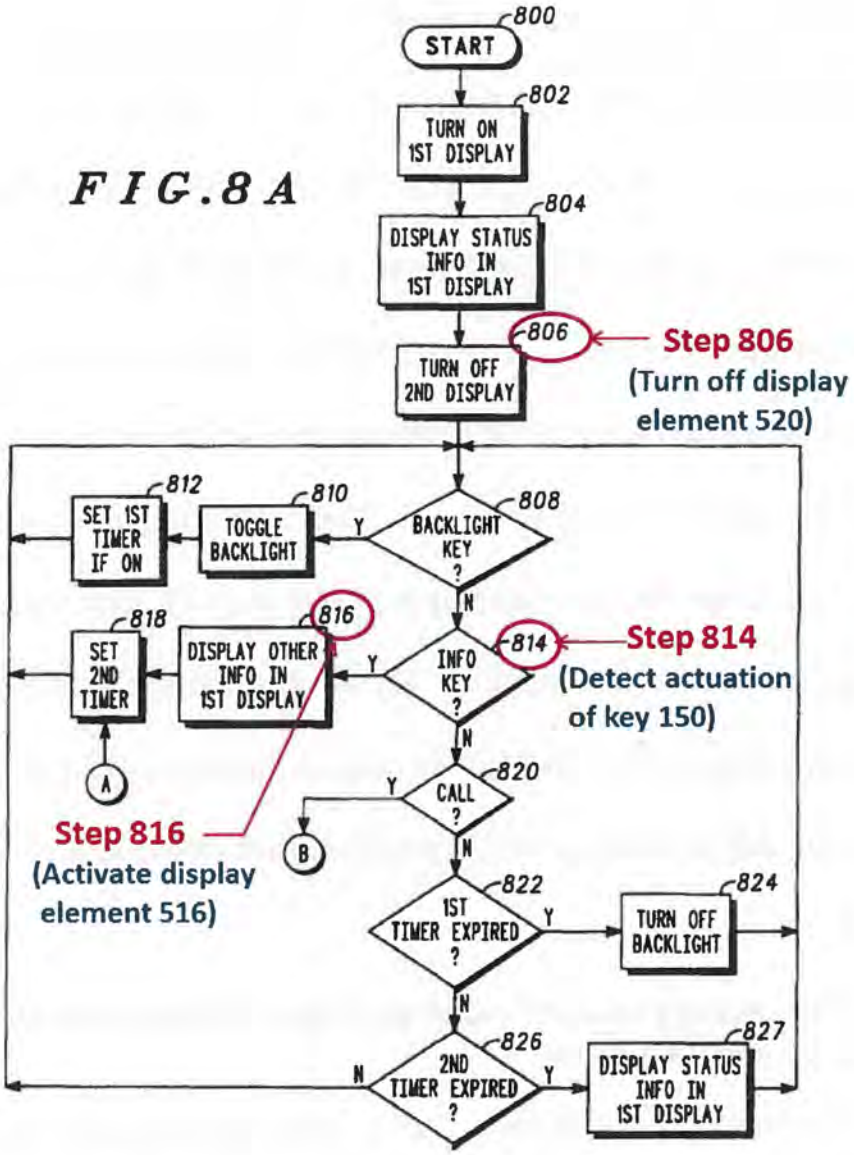
C. Limitation [b] of Claim 21: Jahagirdar taught "activating the indicator in response to a user interface switch activation signal . . . when the load is not activated by the user . . . performing an automatic delayed deactivation of a function . . ."

110. The last part of claim 21 (limitation [b]) reads: "wherein the method

includes the steps of: (a) activating the indicator in response to a user interface switch activation signal; (b) activating the indicator when the load is not activated by the user; (c) performing an automatic delayed deactivation of a function that was activated in response to an activation signal received via the user interface switch." Jahagirdar taught all elements of limitation [b].

111. Jahagirdar disclosed that its display element 516 was activated in response to a user interface switch activation signal received from key 150 (of the plurality of keys 144 which were part of Jahagirdar's user interface). Ex. 1004 (Jahagirdar) at col. 5 ll. 54-65. Referring to Figure 8A, shown below, Jahagirdar disclosed "[i]f controller 504 detects an actuation of key 150 (step 814), controller 504 sends display data to driver 514, which sends display data to display element 516. For [sic] displaying new visual information in display area 130." *Id.* at col. 5 ll. 54-57.

FIG. 8A



112. Jahagirdar also disclosed that display element 516 could be activated when the load (display element 520) was not activated by the user. *See id.* at col. 5 ll. 35-37. Referring again to Figure 8A, shown above, Jahagirdar disclosed that prior to the key actuation detection (step 814) and the step of displaying a visible indicator (step 816), display element 520 was turned off at step 806. *See id.*

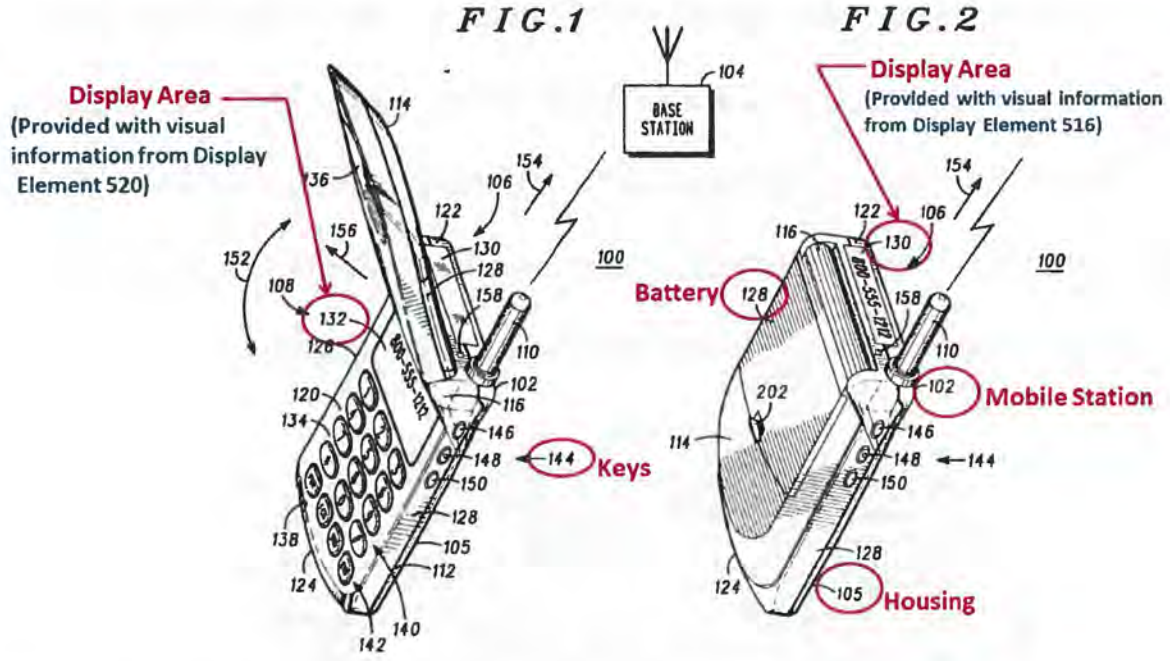
Jahagirdar described that "[i]f power was previously enabled for driver 518 and display element 520, controller 504 disables power thereto (step 806)." *Id.* Since display element 520 was already off at step 806, activation of the visible indicator at step 816 could occur when the load was not activated by the user. *See id.*

113. Additionally, Jahagirdar's user interface had an automatic delayed deactivation of a function activated in response to an activation signal received via the user interface switch. *See id.* at col. 5 ll. 55-65. Referring again to Figure 8A above, after "controller 504 sends display data to driver 514, which sends display data to display element 516" at step 816, "[c]ontroller 504 sets a timer related to the new display information (step 818)" in order to automatically deactivate the visible indicator, display element 516, a predetermined period of time after it was activated. *Id.*

XVIII. Dependent Claim 23 would have been obvious over Jahagirdar in combination with Schultz

114. Claim 23 depends from claim 21. Thus, my analysis for claim 23 incorporates my entire analysis for claim 21, as set forth above. In addition to what I have explained in that analysis, I note that, Jahagirdar described all of the additional limitations of claim 23, rendering claim 23 obvious. Claim 23 reads: "The method of claim 21, wherein the touch sensor switch sense pad is integral with the product housing."

115. Referring to Figures 1 and 2 below, Jahagirdar disclosed that keys 144 were integral with housing 105. Ex. 1004 (Jahagirdar) at col. 2 l. 13, figs. 1-2. As I already described in relation to claim 21, it would have been obvious to incorporate Schultz's touch sensors into Jahagirdar. *See supra* Section XVII. Doing so would have resulted in a touch-sensor-switch sense pad that was integral with the housing 105 of the mobile station 102.



XIX. The Challenged Claims Would Have Been Obvious Under the Construction of "Energy Consuming Load" Advanced by Apple

116. I have been provided with a copy of a Petition for *Inter Partes* Review of U.S. Patent No. 7,994,726, as well as a Declaration of Paul Beard in Support of Petition for *Inter Partes* Review of U.S. Patent No. 7,994,726. The Petition

indicates that it was filed by Apple Inc. and Motorola Mobility LLC (collectively, "Apple"). Although I have not yet reviewed the Petition and the Declaration in their entirety, I have reviewed the claim constructions proposed by Apple for "energy consuming load," which are proposed to mean "any part of the product that consumes energy." I considered whether that construction, if adopted for the corresponding terms in the Challenged Claims, would change my opinions set forth in this declaration. My conclusion is that my opinions would not change in light of claim construction proposed by Apple and Dr. Beard. In the event that this construction for "energy consuming load" is applied, it is still my opinion that the Challenged Claims would have been obvious to one of ordinary skill in the art in view of the same prior art, and for the same reasons I set forth above.

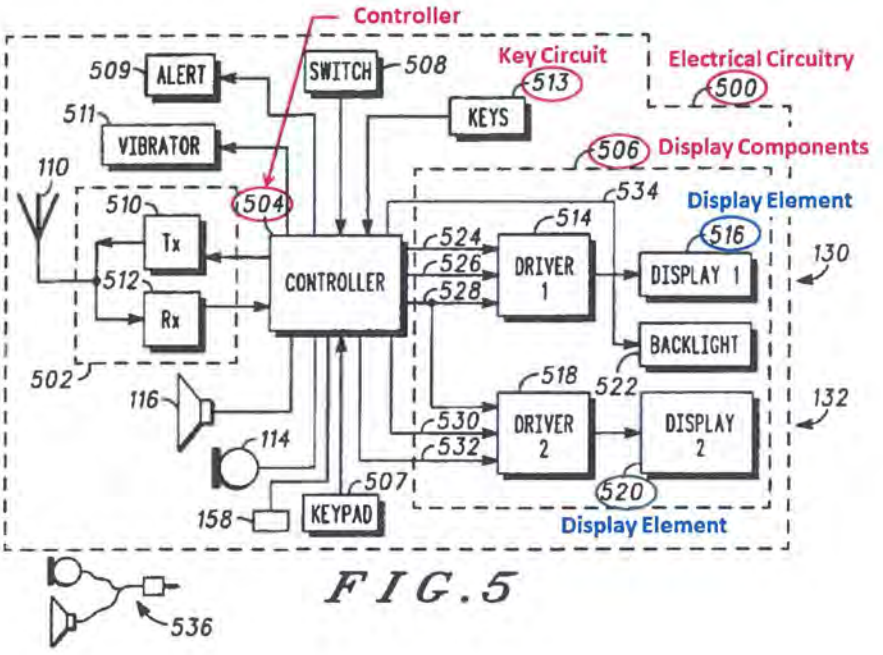


FIG. 5

117. In my analysis, set forth in detail above and throughout this declaration, I designated the claimed load to be display element 520 in Jahagirdar, illustrated for example in Figure 5 above. *See* Ex. 1004 (Jahagirdar) at fig. 5; *see supra* at ¶ 31. Jahagirdar's display element 520 was a part of the product (mobile station 102) as illustrated, and the display element 520 consumed energy. Ex. 1004 (Jahagirdar) at fig. 5. The display element 520 was exemplified as a light emitting diode display or a liquid crystal display, either one of which would consume energy to function. *Id.* at col. 4 ll. 43-46. As Jahagirdar explained, the controller 504 controlled *power* to the display element 520, meaning that the display element received power and thus, consumed energy. *Id.* at col. 4 ll. 31-32. Therefore, Jahagirdar's display element 520 meets the construction "any part of the product that consumes energy," and otherwise, my opinion is exactly the same.

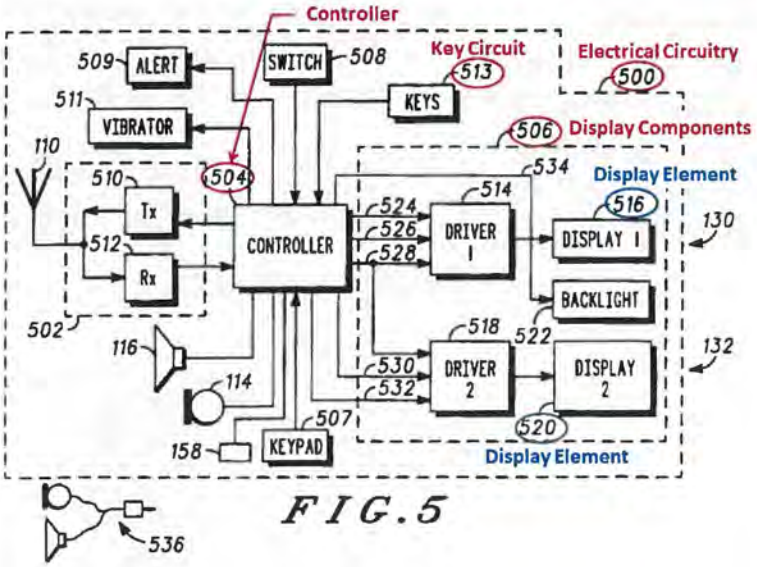
118. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment,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

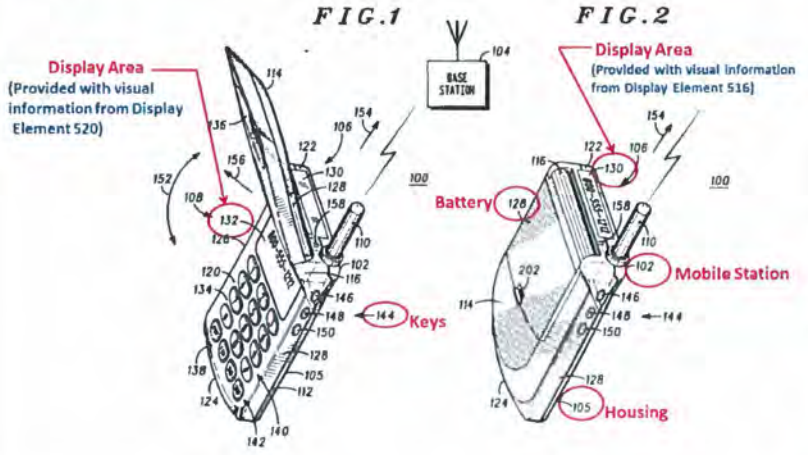
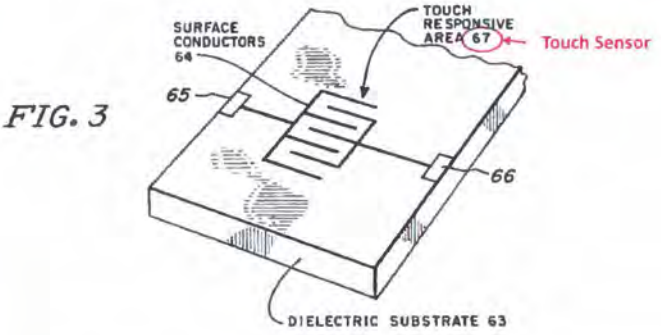
Dated: JUL 2, 2016

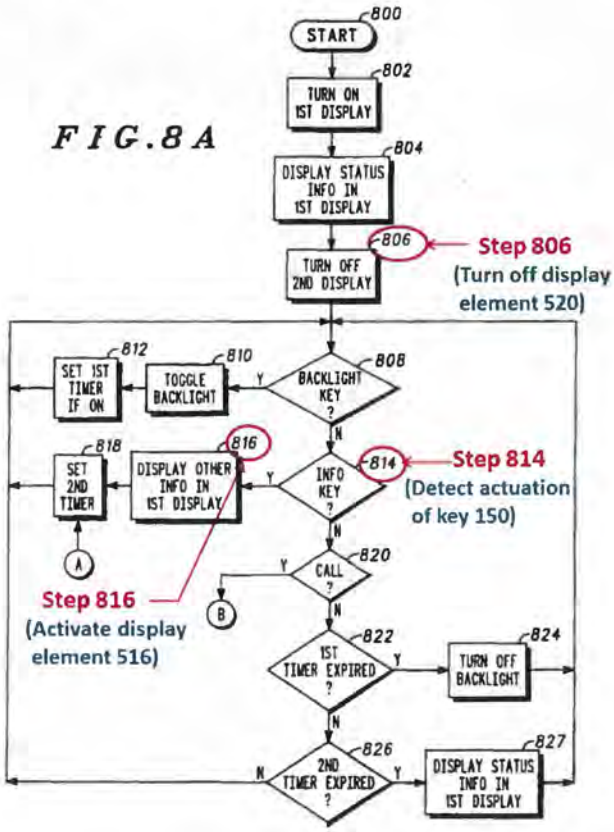
Mark N. Horenstein, Ph.D., P.E.

Boston, Massachusetts

Attachment A to Ex. 1011 (Hornstein Decl.)
Claim Chart for U.S. Patent No. 7,498,749

Claim Element of Challenged Claim	Recitation in Prior Art
1. An electronic unit for use with a product comprising connections for a power source and at least one energy consuming load, said unit comprising:	• Jahagirdar's electrical circuitry 500 = "An electronic unit" • Jahagirdar's mobile station 102 = "a product" • Jahagirdar's battery 128 = "a power source" • "Mobile station 102 also includes a removable battery 128." Ex. 1004 (Jahagirdar) at col. 3 l. 33. • Jahagirdar's display element 520 = "at least one energy consuming load" • Fig. 5 of Jahagirdar:  FIG. 5

	• "Display elements 516 and 520 provide visual information in display areas 130 and 132, respectively." *Id.* at col. 4 ll. 40-41. • Figs. 1 and 2 of Jahagirdar: 
(a) a microchip connected to a user interface switch structure, said structure comprising at least one switch, being a touch sensor type switch that includes a sense pad;	• Jahagirdar's controller 504 = "a microchip" • Jahagirdar's key circuit 513 and plurality of keys 144 = "a user interface switch structure" (Jahagirdar's plurality of keys 144) = "at least one switch" • Schultz's touch responsive area = "a touch sensor type switch that includes a sense pad" • Fig. 3 of Schultz: 

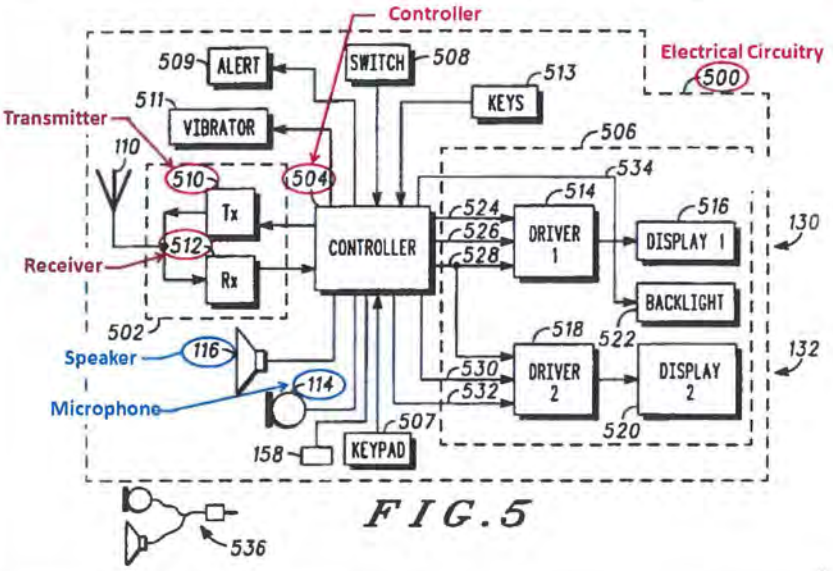
(b) a visible indicator controlled by the microchip to provide at least an indicator activation function when a signal is received through said user interface switch, wherein the indicator is active when the load is not activated by the user;	• Jahagirdar's display element 516 = "a visible indicator" • "Display elements 516 and 520 provide visual information in display areas 130 and 132, respectively." Ex. 1004 (Jahagirdar) at col. 4 ll. 40-41. • "If controller 504 detects an actuation of key 150 (step 814), controller 504 sends display data to driver 514, which sends display data to display element 516. For [sic] displaying new visual information in display area 130." *Id.* at col. 5 ll. 54-57. • "If power was previously enabled for driver 518 and display element 520, controller 504 disables power thereto (step 806)." *Id.* at col. 5 ll. 35-37. • Fig. 8A of Jahagirdar: *FIG. 8A* 

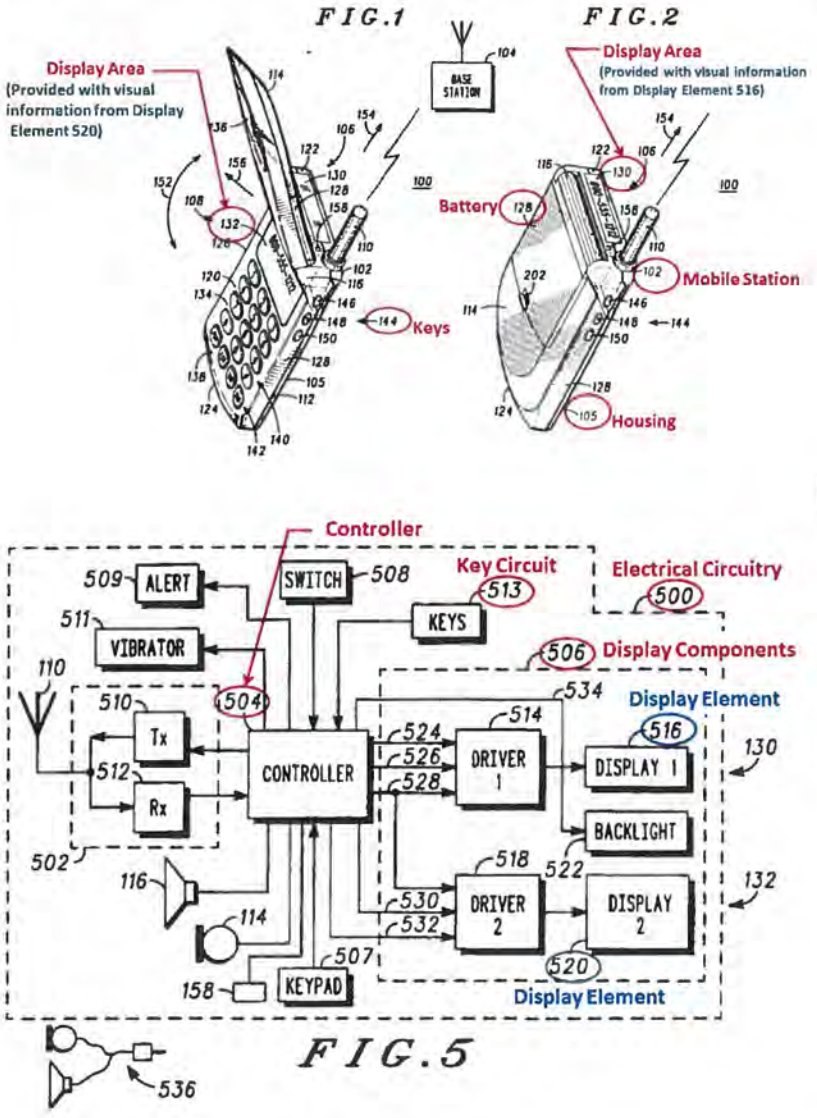
(c) wherein the microchip at least partially implements the touch sensor switch and the user interface has at least one of: (i) an automatic delayed deactivation of a function a predetermined period after the function was activated with an activation command received from the touch sensor switch; (ii) the indicator, in response to the microchip receiving a user interface switch signal, activated to indicate conditions of the product; and (iii) a touch sensor switch sense pad being integral with a housing of the product.	• "[K]ey circuit 513 provides signals to controller [504] in response to actuations of the plurality of keys 144." *Id.* at col. 4 ll. 19-20. • After "controller 504 sends display data to driver 514, which sends display data to display element 516" at step 816, "[c]ontroller 504 sets a timer related to the new display information (step 818)" in order to automatically deactivate the visible indicator, display element 516, a predetermined period of time after it was activated. *Id.* at col. 5 ll. 55-65. • Jahagirdar's display element 516 displayed visual information such as "status information, and may include date and time information, battery status information such as a battery level indication and/or a low battery warning indication." *Id.* at col. 5 ll. 59-61. • Figs. 1 and 2 of Jahagirdar disclosed that keys 144 are integral with housing 105.

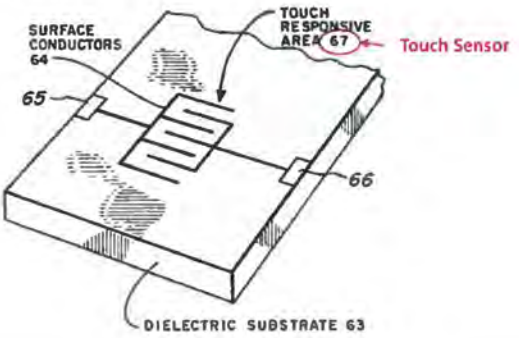
2. An electronic unit according to claim 1, wherein the user interface has at least two features selected from the group consisting of: (i) an automatic delayed deactivation of a function a predetermined period after the function was activated with an activation command received from the touch sensor switch; (ii) the indicator, in response to the microchip receiving a user interface switch signal, activated to indicate conditions of the product; and (iii) a touch sensor switch sense pad being integral with a housing of the product.	• After "controller 504 sends display data to driver 514, which sends display data to display element 516" at step 816, "[c]ontroller 504 sets a timer related to the new display information (step 818)" in order to automatically deactivate the visible indicator, display element 516, a predetermined period of time after it was activated. *Id.* at col. 5 ll. 55-65. • Jahagirdar's display element 516 displayed visual information such as "status information, and may include date and time information, battery status information such as a battery level indication and/or a low battery warning indication." *Id.* at col. 5 ll. 59-61. • Figs. 1 and 2 of Jahagirdar disclosed that keys 144 are integral with housing 105.

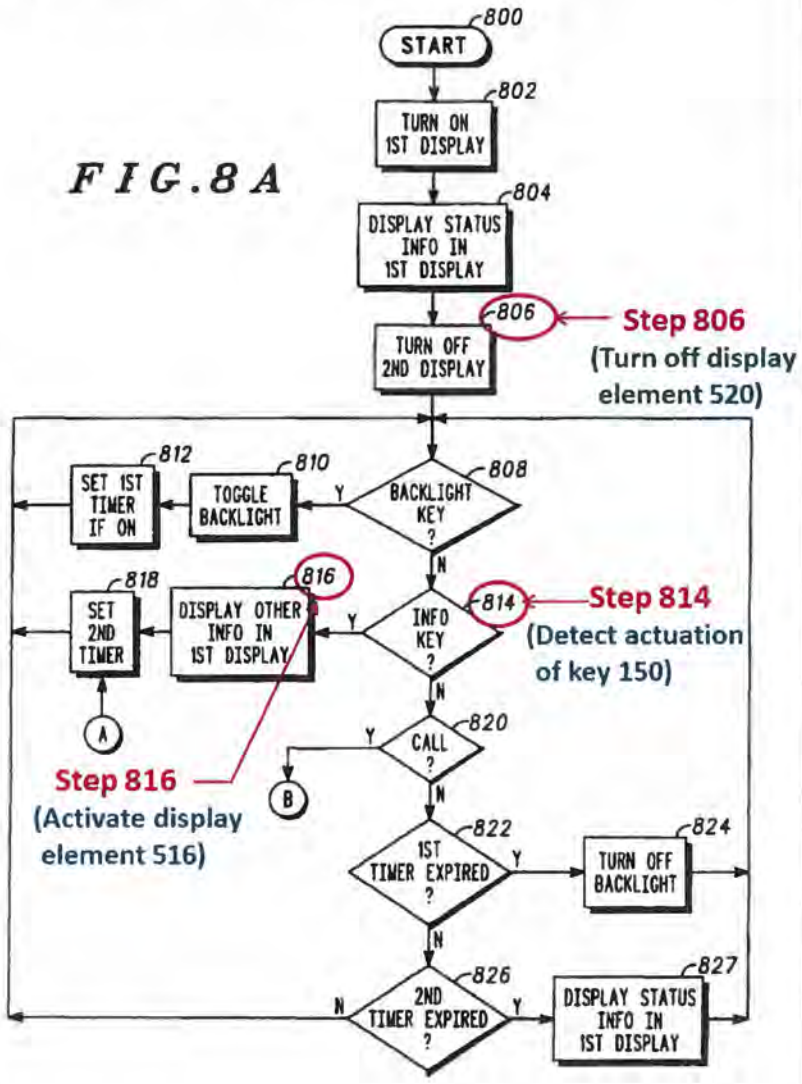
5. An electronic unit according to claim 1, wherein the user interface offers at least a feature comprising the indicator, in response to the microchip receiving a user interface switch signal, activated to indicate conditions of the product.	• Jahagirdar's display element 516 displayed visual information such as "status information, and may include date and time information, battery status information such as a battery level indication and/or a low battery warning indication." *Id.* at col. 5 ll. 59-61.
6. An electronic unit according to claim 1, wherein the user interface offers at least a feature comprising a touch sensor switch sense pad being integral with a housing of the product.	• Figures 1 and 2, Jahagirdar disclosed the feature that keys 144 are integral with housing 105.
7. An electronic unit according to claim 1, wherein the power source is non-mains and the indicator gives at least an indication of a power supply level.	• "Mobile station 102 also includes a removable battery 128." *Id.* at col. 3 l. 33. • Jahagirdar's display element 516 provided an indication of a power supply level: "battery status information such as a battery level indication and/or a low battery warning indication." *Id.* at col. 5 ll. 60-61.

14. An electronic unit according to claim 1, wherein the product comprises RF circuitry and/or audible sound signal generating electronics.	• Jahagirdar's mobile station 102 uses "radio frequency (RF) signals to provide wireless communications and features such as paging, telephone, and short messaging features." *Id.* at col. 2 ll. 7-10. • "Receiver 512 receives RF signals through antenna 110 and demodulates the RF signals." *Id.* at col. 4 ll. 2-4. • "Electrical circuitry 500 [that] includes . . . microphone 114, and speaker 116." *Id.* at col. 3 ll. 60-64. • "Microphone 114 and speaker 116 are coupled to controller 504 through audio circuitry (not shown)." *Id.* at col. 4 ll. 11-13. • "Controller 504 is coupled to and receives the demodulated information from receiver 512. Such information includes control information and may include voice information which is processed and sent to speaker 116. Controller 504 is coupled to transmitter 510 and sends information thereto for transmission. Such information includes control information and may include voice information received from microphone 114." *Id.* at col. 4 ll. 4-11. • Fig. 5 of Jahagirdar:

	 FIG. 5
15. An electronic unit according to claim 1, wherein power source is a non-mains power source.	• "Mobile station 102 also includes a removable battery 128." *Id.* at col. 3 l. 33.

21. A method of implementing a user interface for a product comprising connections for a power supply and at least one energy consuming load,	• Jahagirdar's key circuit 513 and plurality of keys 144 = "a user interface" • Jahagirdar's mobile station 102 = "a product" • Jahagirdar's battery 128= "a power supply" • Jahagirdar's display element 520 = "at least one energy consuming load" • Figs. 1, 2, and 5 of Jahagirdar: 

using at least a touch sensor user interface switch and a visible indicator,	• Jahagirdar's display element 516 = "a visible indicator" • Schultz's touch responsive area 67 = "a touch sensor user interface switch" • Fig. 3 of Schultz: FIG. 3 

wherein the method includes the steps of: (a) activating the indicator in response to a user interface switch activation signal; (b) activating the indicator when the load is not activated by the user; (c) performing an automatic delayed deactivation of a function that was activated in response to an activation signal received via the user interface switch.	• "If controller 504 detects an actuation of key 150 (step 814), controller 504 sends display data to driver 514, which sends display data to display element 516. For [sic] displaying new visual information in display area 130." Ex. 1004 (Jahagirdar) at col. 5 ll. 54-57. • Fig. 8A of Jahagirdar: *FIG. 8A*  • "If power was previously enabled for driver 518 and display element 520, controller 504 disables power thereto (step 806)." *Id.* at col. 5 ll. 35-37. • After "controller 504 sends display data to driver 514,

	which sends display data to display element 516" at step 816, "[c]ontroller 504 sets a timer related to the new display information (step 818)" in order to automatically deactivate the visible indicator, display element 516, a predetermined period of time after it was activated. *Id.* at col. 5 ll. 55-65.
23. The method of claim 21, wherein the touch sensor switch sense pad is integral with the product housing.	• Figs. 1 and 2 of Jahagirdar disclosed that keys 144 are integral with housing 105.

Attachment B to Ex. 1011 (Hornstein Decl.)

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Areas of Expertise
Applied Electromagnetics, Electrostatics, Circuit Design, Electric Power Systems

Education

Massachusetts Institute of Technology	Ph.D. Electrical Engineering	1978
University of California at Berkeley	M.S. Electrical Engineering	1975
Massachusetts Institute of Technology	S.B. Electrical Engineering	1973

Employment History
Boston University:

Professor, Dept. of Electrical and Computer Engineering	2000 - present
Associate Dean for Graduate Programs and Research, College of Engineering	1999 - 2007
Associate Professor, Dept. of Electrical and Computer Engineering	1985 - 2000
Assistant Professor, Dept. of Electrical and Computer Engineering	1979 - 1985

Spire Corporation, Research Scientist, Pulse Power Systems 1978 - 1979

Professional Affiliations
Institute of Electrical and Electronic Engineers (Senior Member)
Registered Professional Engineer (Massachusetts)
National Association of Radio and Telecommunications Engineers (Certified ESD Engineer)
Journal of Electrostatics (Editor in Chief (2000- 2015)
Electrostatics Society of America (Past President and Executive Board)

Current and Past Research Activities
Transdermal Injection of Drug-Laden Nanoparticles via Electrostatic Pulsed
Self-Cleaning Solar Panels via Electrodynamic Electric Field Screen
Multiplexing Circuit for Large-Array MEMS Mirrors used in Space Exploration
Neuron Interface Microchip via Neurotransmitter Stimulation (with FCMI)
Laparoscopic Hand Surgical Tool (Fraunhofer Alliance)

Courses Taught (past five years)
Senior Design Project, Electric Circuit Theory, Electronics, Electromagnetics, Power Electronics

Publications

Books:
M. N. Horenstein, *Design Concepts for Engineers,5th Edition*. Upper Saddle River, NJ: Prentice Hall, 2015.

M. N. Horenstein, *Microelectronic Circuits and Devices, 2nd Ed.* Upper Saddle River, NJ: Prentice Hall, 1996. (Translated editions available in Spanish, Portuguese, and Chinese.)

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MN Horenstein, MK Mazumder, R Sumner, J Stark, et al, "Modeling of trajectories in an electrodynamic screen for obtaining maximum particle removal efficiency" 2011 IEEE Industry Applications Society Annual Meeting, p 7 pp., 2011

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- M. Horenstein, "Method and Apparatus for Detecting Leaks in Electrically-Insulative Protective Articles such as Condoms, Surgical Gloves, and the Like Using Gaseous Electrostatic Ions."
- Jackson and M. Horenstein, "Nasopharyngealometric Apparatus and Method"
- T. Bifano and M. Horenstein, "MEMS-based spatial-light modulator with integrated electronics"