

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Harvey et al.
U.S. Patent No.: 8,711,885 Attorney Docket No.: 39842-0033IP2
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Appl. Serial No.: 08/459,507
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Title: SIGNAL PROCESSING APPARATUS AND METHODS

DECLARATION OF DR. JOHN VILLASENOR

I. Introduction

1. I have been retained on behalf of Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. to offer technical opinions relating to U.S. Patent No. 8,711,885 (the '885 Patent), and prior art references relating to its subject matter. I have reviewed the '885 Patent and relevant excerpts of the prosecution history of the '885 Patent. Additionally, I have reviewed the following: U.S. Patent No. 4,789,895 to Mustafa et al. ("Mustafa"), WO 81/002961 to Campbell et al. ("Campbell-1A"), U.S. Patent No. 4,536,791 to Campbell et al. ("Campbell-1B"), the file history of U.S. Application No. 06/135,987 to Campbell et al. ("Campbell-1C), U.S. Patent No. 4,225,884 to Block et al. ("Block"), and U.S. Patent No. 4,829,569 to Seth-Smith et al. ("Seth-Smith").

2. Counsel has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '885 Patent at the time of the earliest possible priority date of the '885 Patent, and I have done so

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during my review of these materials. The application leading to the '885 Patent was filed on June 2, 1995, and claims priority through a chain of continuations to a continuation-in-part filed on September 11, 1987 (hereinafter the "Critical Date"). Counsel has informed me that the Critical Date represents the earliest possible priority date to which the challenged claims of the '885 patent are entitled, and I have therefore used that Critical Date in my analysis herein.

3. I have no financial interest in either party or in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

4. My opinions, as explained below, are based on my education, experience, and background in the fields discussed above. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the fields as of the Critical Date, or before.

5. This declaration is organized as follows:

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II. Qualifications and Experience

6. I received a B.S. in electrical engineering from the University of Virginia in 1985, an M.S. in electrical engineering from Stanford University in 1986, and a Ph.D. in electrical engineering from Stanford University in 1989. During my graduate study at Stanford (1985-1989), I performed research on communications and signal processing.

7. Between 1990 and 1992, I worked for the Jet Propulsion Laboratory in Pasadena, CA, where I worked to develop techniques for imaging and mapping the earth from space. Since 1992, I have been on the faculty of the Electrical Engineering Department of the University of California, Los Angeles (UCLA). Between 1992 and 1996, I was an Assistant Professor; between 1996 and 1998, an Associate Professor; and since 1998, I have been a full Professor. For several years starting in the late 1990s, I served as the Vice Chair of the Electrical Engineering Department at UCLA. I also hold faculty appointments in the UCLA Anderson School of Management and in the Department of Public Policy within

the UCLA Luskin School of Public Affairs. I am also a visiting professor at the UCLA School of Law.

8. In the engineering school at UCLA, I teach courses on information processing and communications, including consideration of systems, algorithms, and devices. At the Anderson School of Management, I created and have taught a course on intellectual property for technology entrepreneurs and also advise second-year MBA students on technology-related team projects. At the Luskin School of Public Affairs, I teach science and technology policy and also advise graduate student project teams. At the UCLA School of Law, I created and teach a course called "Digital Technologies and the Constitution."

9. Over the past several decades I have performed extensive research on various aspects of systems, devices, and networks that acquire, store, process and transmit information. My research has addressed software, algorithms, hardware, networking, protocols and other aspects of these systems and devices, and has included work on wireless mobile devices and systems, signal processing and communications, hardware design methodologies, and cybersecurity. For example, in the 1990s I was working on technologies for what today is referred to as the Internet of Things.

10. I am an inventor on approximately 20 U.S. patents in areas including signal processing, data compression, communications, and cybersecurity. I have

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published over 150 technical articles in peer-reviewed engineering journals and conference proceedings. I have also been asked on multiple occasions to provide congressional testimony in relation to technology topics. In addition, I have published articles in the legal academic press, including law review articles.

11. In addition to my work at UCLA, I am a nonresident senior fellow at the Brookings Institution in Washington, D.C. Through Brookings I have examined a wide range of topics at the technology/policy intersection including cybersecurity, wireless mobile devices and systems, digital privacy, financial inclusion for "unbanked" populations, driverless cars, and digital currencies. In addition to publishing in traditional academic venues such as engineering journals, engineering conference proceedings, and law reviews, I have published papers and reports through the Brookings Institution. I have also published articles and commentary in broader-interest venues including Billboard, the Chronicle of Higher Education, Fast Company, Forbes, the Huffington Post, the Los Angeles Times, Scientific American, Slate, and the Washington Post.

12. I am an affiliate of the Center for International Security and Cooperation (CISAC) at Stanford, and from 2014 to 2016 I was a National Fellow at the Hoover Institution at Stanford. At Stanford I direct a research project funded by the U.S. Department of Homeland Security aimed at improving cybersecurity in U.S. critical infrastructure.

13. I am also a member of the Council on Foreign Relations and a member of the World Economic Forum's Global Agenda Council on Cybersecurity. Previously I was a member and then vice chair of the World Economic Forum's Global Agenda Council on the Intellectual Property System.

14. Since the late 1990s, I have had significant engagement in early stage technology venture capital in the San Francisco Bay Area. In that capacity I have met with a large number of startup companies seeking venture financing spanning a wide range of technology areas, including mobile communications devices and systems. Among other things, I have helped to evaluate the proposed technology, the competitive landscape, the market opportunities and risk, the strength of the team, and the company's IP strategy and position.

15. My curriculum vitae is attached to this declaration as Exhibit SAMSUNG-1004.

III. Level of Ordinary Skill in the Art

16. In my opinion, a person of ordinary skill in the art as of the Critical Date (hereinafter "APOSITA") would have had a Bachelor of Science Degree in electrical engineering or a closely related field with two years of experience in communications technology. Alternatively, APOSITA with less than the amount of educational training noted above could have had a correspondingly greater

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amount of experience in the relevant field. I base this on my own personal experience, including my knowledge of colleagues and others at the time.

IV. Legal Understandings

A. Terminology

17. I have been informed by Counsel and understand that claim terminology must be given the broadest reasonable interpretation during an IPR *inter partes review* proceeding. I have been informed by Counsel and understand that this means the claims should be interpreted as broadly as their terms reasonably allow, but that such interpretation should not be inconsistent with the patent's specification and with usage of the terms by a person of ordinary skill in the art at the time of invention. Counsel has also informed me, and I understand, that this may yield interpretations that are broader than the interpretation applied during District Court or ITC proceedings.

B. Legal Standards for Anticipation

18. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as anticipated. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art at the time of the invention.

19. I am informed by Counsel and understand that a challenged claim is unpatentable as “anticipated” under 35 U.S.C. § 102 (in the pre-AIA form of that statute that applies to the ’885 Patent) if it is determined that all the limitations of the claim are described in a single prior art reference. I am informed by Counsel and understand that, to anticipate a claim, a prior art reference must disclose, either expressly or inherently, each and every limitation of that claim and enable one of ordinary skill in the art to make and use the invention.

20. I have been informed by Counsel and understand that in an *inter partes* review, “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of anticipation, “by a preponderance of the evidence.” 35 U.S.C. §316(e).

C. Legal Standards for Obviousness

21. I understand I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as obvious. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art at the time of the invention, and that this viewpoint prevents one from using his or her own insight or hindsight in deciding whether a claim is obvious.

22. I have been informed by Counsel and understand that a claim is unpatentable for obviousness under 35 U.S.C. § 103 (in the pre-AIA form of that

statute that applies to the '885 Patent) “if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” I am informed by Counsel and understand that obviousness may be based upon a combination of references. I am informed by Counsel and 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. However, I am informed by Counsel and understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.

23. I am informed by Counsel and understand that when a patented invention is a combination of known elements, a court must determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in the field or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

24. I am informed by Counsel and understand that a patent claim composed of several limitations is not proved obvious merely by demonstrating

that each of its limitations was independently known in the prior art. I am informed by Counsel and understand that identifying a reason those elements would be combined can be important because inventions in many instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known. I am informed by Counsel and understand that it is improper to use hindsight in an obviousness analysis, and that a patent's claims should not be used as a “roadmap.”

25. I am informed by Counsel and understand that an obviousness inquiry requires consideration of the following factors: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the pertinent art; and (4) any objective indicia of non-obviousness, such as commercial success, long-felt but unresolved need, failure of others, industry recognition, copying, and unexpected results. I understand that the foregoing factors are sometimes referred to as the “Graham factors.”¹

26. I have been informed by Counsel and understand that an obviousness evaluation can be based on a combination of multiple prior art references. I understand that the prior art references themselves may provide a suggestion,

¹ See *KSR Int’l v. Teleflex Inc.*, 550 U.S. 398, 406-407 (2007) (quoting *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966)).

motivation, or reason to combine, but that the nexus linking two or more prior art references is sometimes simple common sense. I have been informed by Counsel and understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

27. I have been informed by Counsel and understand that if a technique has been used to improve one device, and a person of ordinary skill at the time of invention would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

28. I have been informed by Counsel and understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I have been informed by Counsel and understand that a person of ordinary skill looking to overcome a problem will often be able to fit together the teachings of multiple prior art references. I have been informed by Counsel and understand that obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill would have employed at the time of invention.

29. I have been informed by Counsel and understand that a proper obviousness analysis focuses on what was known or obvious to a person of

ordinary skill at the time of invention, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

30. I have been informed by Counsel and understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

31. I have been informed by Counsel and understand that secondary indicia of non-obviousness may include (1) a long felt but unmet need in the prior art that was satisfied by the invention of the patent; (2) commercial success of processes covered by the patent; (3) unexpected results achieved by the invention; (4) praise of the invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the invention; (7) failure of others to find a solution to the long felt need; and (8) skepticism by experts. I understand that evidence of secondary indicia of non-obviousness, if available, should be considered as part of the obviousness analysis.

32. I have been informed by Counsel and understand that there must be a relationship between any such secondary considerations and the invention, and that

contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination.

33. In sum, my understanding is that prior art teachings are properly combined where APOSITA having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

34. I have been informed by Counsel and understand that in an *inter partes* review, “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of obviousness, “by a preponderance of the evidence.” 35 U.S.C. §316(e).

V. Overview of the '885 Patent

A. Description of the '885 Patent

35. The '885 Patent generally relates to the transmission, reception, processing, and presentation of information carried on various types of electronic signals (e.g., standard radio and television signals) ['885 Patent at Abstract]. In the Patent Owner’s own words, “[t]he system encompasses the prior art (television,

radio, broadcast hardcopy, computer communications, etc.)” [’885 Patent at Abstract].

B. Challenged Claims of the ’885 Patent

36. Counsel has informed me that the claims of the ’885 Patent that are being challenged in the IPR petition accompanying this affidavit ("Challenged Claims") are claims 1, 102, 105, and 106. The discussions below are in reference to the Challenged Claims of the ’885 Patent.

37. The Challenged Claims relate to methods for controlling the communication of signals at a receiver station and processing signals at receivers [’885 Patent at Claim 1 and Claim 102]. The receiver station accepts a conventional television broadcast transmission via conventional antenna [’885 Patent at 10:42-44]. Digital information, including information that causes the receiver to perform particular functions, is embedded in the broadcast [’885 Patent at 7:51-63]. A television connected to the receiver then presents received video and audio information [’885 Patent at FIG. 1, 11:20-23].

C. Claim Terms

a. “valve” (claim 1)

38. In my opinion, a “valve” should be construed as “a device that regulates the flow of information.” While the term “valve” appears throughout the specification, the term is not defined with respect to a limitation on the

embodiment of the valve. Rather, the specification describes that the valve “receives inputted” transmission information and “outputs information” to “external receiving apparatus” [’885 Patent at 36:1-22].

b. “processor” (claims 1, 102, 105, and 106)

39. In my opinion, a “processor” should be construed as “a device or module that operates on digital or analog signals.” While the term “processor” appears throughout the specification, the term is not defined with respect to a limitation on the functionality of the processor.

40. The term processor had a well-known meaning in the art as a component which “operates on data.” Nothing in the specification suggests deviation from this well-accepted definition. The specification recites many different types of processors which perform different types of operation on data. *See, e.g., id.*, 8:53-55 (describing a processor that “organize[s] and transfer[s] the in-formation stream”); *id.*, 16:5-7 (describing a “signal processor” which “identifies specific programming and its subject matter as said programming becomes available for use.”) The claims here, though, do not recite any specific type of processor, instead claiming broadly the generic term “processor.”

41. In the context of other PMC patents that share the same or a similar specification, the Board has consistently interpreted a “processor” as “a device that operates on data.” *See* IPR-2014-01532, Paper 57, 12; IPR2016-00753, Paper, 12;

IPR2014-01534, Paper 55, 12. In fact, the PMC itself has proposed a similar construction in district court litigation for a related patent having the same specification: “any device capable of performing operations on data.” Ex SAMSUNG-1012, 12.

42. In addition, Board decisions have recognized that a “processor” operates on more than just digital data. For example, the Board was “satisfied” that components of Campbell-1A which unambiguously operate on both digital and analog information “collectively form a ‘video output processor.’” See IPR2016-00753, Paper 8, 48; *see also id.* at 11 (rejecting Patent Owner’s proposed constructions as “a device that execute[s] instructions or process[es] data according to instructions. In addition, nothing in the specification suggests that “processors” operate only on digital data. For example, FIG. 2 of the ’885 Patent shows a “signal processor” which unambiguously operates on analog data as well.

43. However, I respectfully believe that the proper construction for processor should be broader than “a device or module that operates on data.” This position is supported by Figure 2D of the ’885 patent which contains a box labeled 26. The ’885 Patent describes 26 as a “signal processor” [generally, ’885 Patent at 21:17-18]. It is clear from Figure 2D that this signal processor is not limited to operating on digital data. For example, as that figure shows, signal processor 26 is capable of receiving cable or broadcast transmissions, demodulating them using a

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local oscillator, and then doing further processing of the radio and television signals therein. Thus, a “processor” in the ’885 Patent can potentially operate on analog signals, and a construction (such as “a device that operates on data”) that might be interpreted to exclude operation on analog signals is too narrow. I believe that the construction I have proposed, “a device or module that operates on digital or analog signals,” is appropriate in light of the BRI standard applied in IPR proceedings.

VI. Overview of Prior Art Reviewed

D. International Publication No. WO 81/02961 to Campbell et al. (“Campbell-1A”), U.S. Patent No. 4,536,791 to Campbell et al. (“Campbell-1B”), and U.S. Patent Application Serial No. 06/135,987 to Campbell et al. (“Campbell-1C”)

44. Campbell-1A was published as International Publication No. WO 81/02961 (“Campbell-1A”) on October 15, 1981 and issued as U.S. Pat. No. 4,536,791 (“Campbell-1B”) on August 20, 1985. Thus, each of Campbell-1A and Campbell-1B separately qualifies as prior art under 35 U.S.C. § 102(b).

45. Campbell-1B, which is a continuation of U.S. Application Serial No. 06/348,937 (“Campbell-1C”). The ’937 Application itself was filed on November 27, 1981 as a CIP of Campbell-1C, which was filed on Mar. 31, 1980. Campbell-1B was filed in the United States on June 4, 1984 while the ’937 Application was still pending. The ’937 Application was not abandoned until about three months

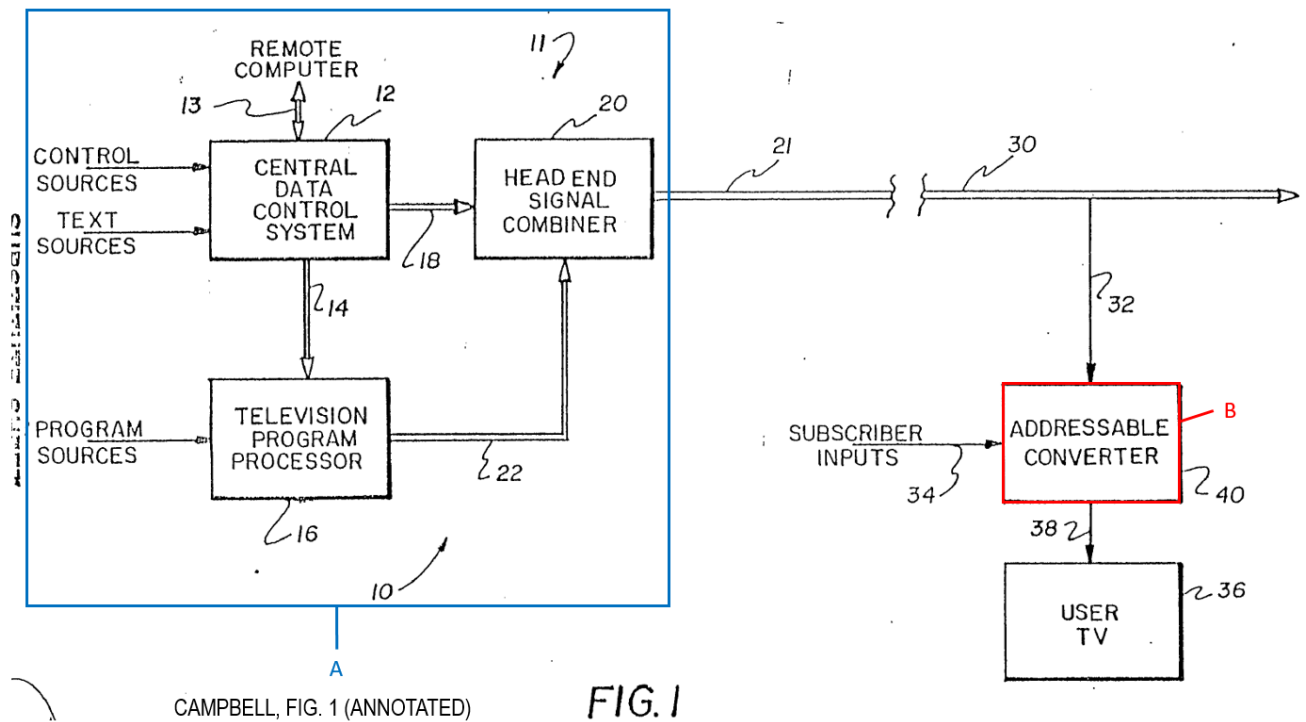
later on September 18, 1984. Furthermore, the '937 Application was filed in the United States on November 27, 1981 while Campbell-1C was still pending. Campbell-1C was not abandoned until about five months later on May 4, 1982. The existence of that same subject matter in the earliest priority document, and therefore support for the claims pursuant to 35 U.S.C. § 112, first paragraph, is included in the accompanying string cites that appear below. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375 (Fed. Cir. 2015).

Campbell '791 Claim 1	Campbell '987 Priority Application Support
1. In television communications system having a central station for transmitting a plurality of television signals at different frequency channels to a plurality of user stations remote from said central stations, each having a tuner for selecting one of said television signals, a method of utilizing said central station to limit access of said user stations to only certain ones of said television signals, comprising:	Claim 1; <i>see also</i> 1:24-2:2, 3:10-14, 5:1-27, FIGS. 1, 2, 6.
transmitting each of said category codes from the central station to its respective user station to precondition each user station by authorization from the central station to selectively access said predetermined categories of television signals;	Claim 1; <i>see also</i> 6:18-26, 7:20-25, p. 8:1-2, 8:30-37, 16:20-28, 17:21-33, FIG. 11.
generating a plurality of program codes at said central station to limit user access to said predetermined categories of television signals, one of said program codes being generated for	Claim 1; <i>see also</i> FIG. 11, 1:24-2:2, 3:10-14, 6:18-26, 17:1-20.

each television signal, each of said program codes including predetermined control data for enabling access to one of said television signals;	
transmitting one of said program codes with each of said television signals to each of said user stations being tuned to receive one of said television signals;	Claim 1; <i>see also</i> FIG. 11, 6:18-26, 17:1-20.
comparing the control data of said program code to the enabling data of the category code provided by the central station to each user station; and	Claim 1; <i>see also</i> 3:22-25, 21:1-22:18, FIG. 12.
enabling only each user station which has a category code with enabling data corresponding to the control data of said program code, whereby said enabled user station can receive and process any said tuned television signal within a predetermined category of said television signals corresponding to said category code.	Claim 1; <i>see also</i> 15:13-22, 21:1-22:18, FIG. 12.

46. Each of Campbell-1A, Campbell-1B, and Campbell-1C generally describe an “addressable cable television control system,” which is illustrated in an annotated version of FIG. 1 below [generally, Campbell-1A at Abstract, FIG. 1; Campbell-1B at Abstract, FIG. 1; Campbell-1C at Abstract, FIG. 1]. The system includes a head end station 10 (A) with components that combine (i) scrambled video signals obtained from multiple program sources, and (ii) data signals from control sources and text sources. The head end station generates a RF data-loaded television signal that is provided for output at multiple receiver stations (B)

[Campbell-1A at FIGS. 2, 3-5; Campbell-1B at FIGS. 2, 3-5; Campbell-1C at FIGS. 2, 3-5].



47. The receiver stations, also denoted in Campbell-1A as “addressable converters,” receive the RF data-loaded television signals, process the television signals, and then provide the embedded video signals for output on an associated television [Campbell-1A at FIGS. 6-8; Campbell-1B at FIGS. 6-8; Campbell-1C at FIGS. 6-8]. Specifically, the addressable converter selectively descrambles the scrambled video signals using various codes discussed in more detail below [Campbell-1A at 19:6-14; Campbell-1B at 12:2-26; Campbell-1C at 26:20-28].

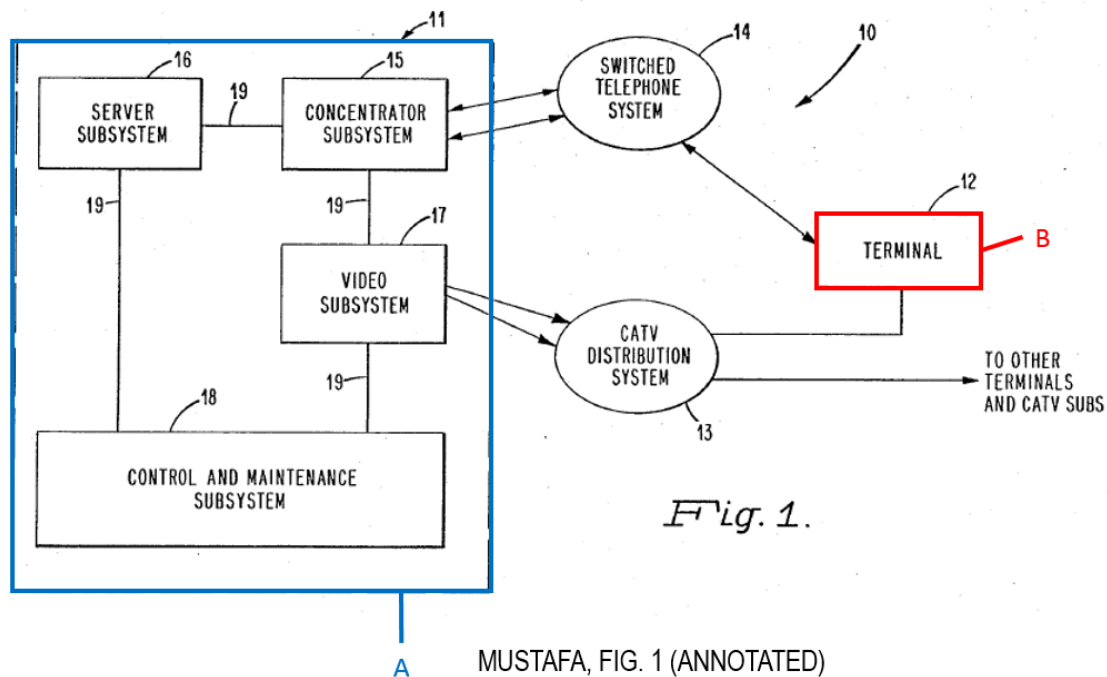
48. Campbell-1A teaches that the system uses various “procedures to restrict access to [] television programming” e.g., “restrictions on the basis of addressable tiers, special events and eligibility codes” [Campbell-1A at 17:33-36; Campbell-1B at 11:66-12:2; Campbell-1C at 14:22-25]. For example, the addressable converter compares the program codes sent from the head end station to user codes identifying the access parameters of each subscriber [Campbell-1A at 17:33-36; Campbell-1B at 11:66-12:2; Campbell-1C at 14:22-25]. The descrambling by the addressable converter can be controlled such that the “descrambling process at the converter is enabled only after the process control parameters are satisfied by the converter” e.g., a correspondence between the received program codes and stored user codes [Campbell-1A at 18:8-12; Campbell-1B at 12:14-18; Campbell-1C at 15:8-12]. This capability enables “remote subscribers [to] have access to different tiers of service regardless of the channel selected depending upon the type of service subscribed to by each user” [Campbell-1A at 18:13-15; Campbell-1B at 12:19-22; Campbell-1C at 15:13-15]. In my opinion, Campbell-1A describes that the system “allows many different programs to be transmitted on a given channel while discriminating between subscribers who may view a given program” [Campbell-1A at 18:15-17; Campbell-1A at 12:22-25; Campbell-1C at 15:15-17].

E. U.S. Patent No. 4,789,895 to Mustafa et al. (“Mustafa”)

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49. U.S. Patent No. 4,789,895 (“Mustafa”) is titled “System for synchronizing digital bit stream for telecommunication system.” The named inventor is Mehmet Mustafa. The patent was filed on April 30, 1987. It is my understanding that Mustafa is prior art to the ’885 Patent.

50. Mustafa describes “[a] telecommunication system,” which is illustrated in an annotated version of Mustafa’s FIG. 1 below [Mustafa at Abstract and FIG. 1].



51. The system includes a Central Facility 11 (A) that transmits a cablecast transmission to one or more terminals 12 (B). The Central Facility is coupled to one or more terminals through a transmission medium having

bandwidth sufficient to carry standard television frames [Mustafa at FIGS. 1, 5].

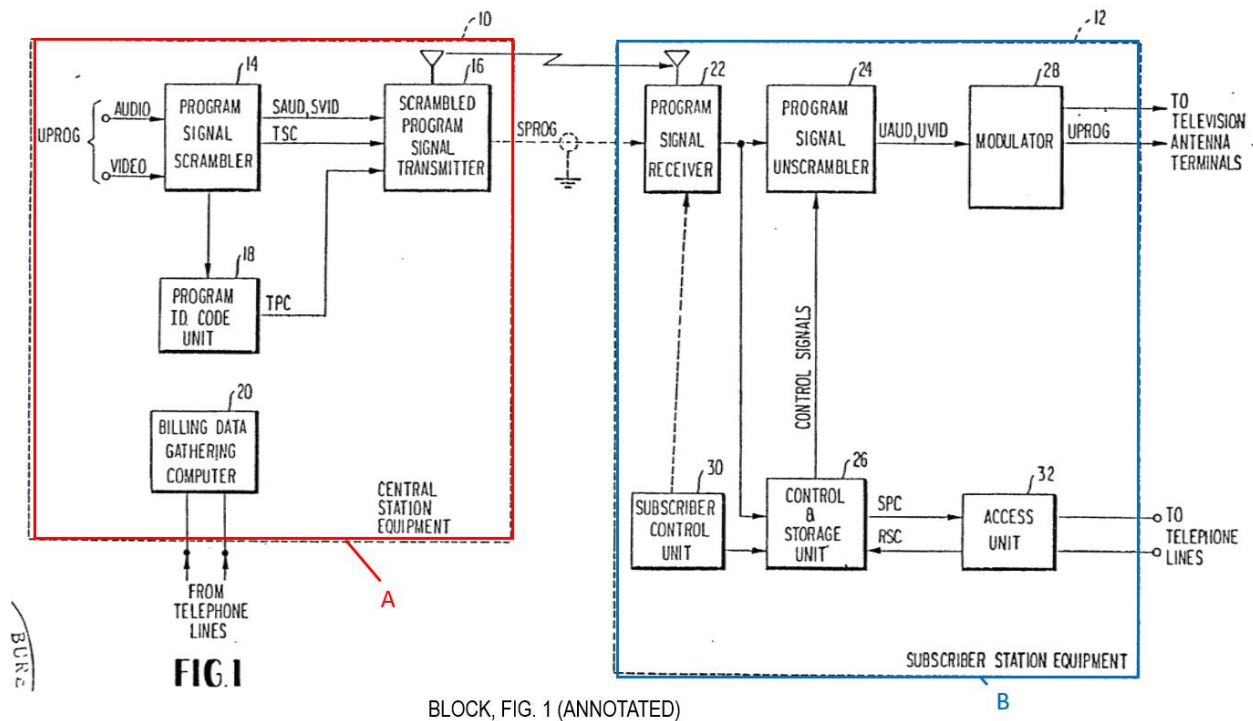
Each terminal receives a stream of television frames, including a plurality of audio channels, and synchronizes video data with audio data for display on an associated television set [Mustafa at FIGS. 1, 5].

52. In more detail, Mustafa describes that a set-top module of the terminal “receiv[es] and process[es] video frames and audio frames sent from the Central Facility and deliver[s] them to the television receiver” [Mustafa at 6:34-41]. A demodulator of the terminal “demodulates the incoming signal to baseband and splits the audio channels from the video and audio frames” [Mustafa at 6:42-68]. The audio channels are extracted from the demodulator and connected to an analog switch that selects baseband audio or SAP audio [Mustafa at 6:42-68]. The video frames are passed through a character generator to insert input from a user, and the selected audio channels are combined with the video for display at a television receiver [Mustafa at 7:1-10:62]. This process allows increased control over a user’s session [Mustafa at 10:7-62].

F. U.S. Patent No. 4,225,884 to Block et. al. (“Block”)

53. Block issued as U.S. Patent Serial No. 4,536,791 on September 30, 1980. Block qualifies as prior art under 35 U.S.C. § 102(b) because it was published more than a year from the Critical Date.

54. Block generally teaches a “subscription television system,” which is illustrated in an annotated version of FIG. 1 below [generally, Block at Abstract and FIG. 1]. The system includes central station equipment 10 (A) that provide scrambled program signals, denoted as “SPROG,” to subscriber station equipment 12 (B) at each of the subscriber stations.



BLOCK, FIG. 1 (ANNOTATED)

55. Block teaches that SPROG includes “scrambled audio and video signals as well as various synchronizing signals and codes” [Block at 3:31-34]. The SPROG is provided “by conventional broadcast or cable techniques” [Block at 3:35-37]. The SPROG received at the subscriber station equipment is “selectively unscrambled to permit viewing of the block of program material being transmitted . . .” [Block at Abstract]. Specifically, the subscriber station equipment compares a

received program code, denoted as “TPC,” within the SPROG to a locally generated category code, denoted as “SPC,” to “determine whether the program is acceptable for viewing” by the subscriber associated with the subscriber station equipment [Block at Abstract]. The SPROG also includes a “transmitted scramble code TSC for transmission,” which is used to selectively scramble “respective scrambled audio and video signals SAUD and SVID” [Block at 3:38-49]. An unscrambled program signal UPROG, which includes an unscrambled audio signal UAUD and an unscrambled video signal UVID, is then provided for output on the subscriber’s television [Block at 3:62-4:9].

G. U.S. Patent No. 4,829,569 to Seth-Smith et al. (“Seth-Smith”)

56. Seth-Smith was filed on July 8, 1986. Seth-Smith qualifies as prior art under 35 U.S.C. § 102(e) because it was filed prior to the Critical Date.

57. Seth-Smith describes a subscription television system which is illustrated in an annotated version of FIG. 13 below [generally, Seth-Smith at Abstract, FIG. 13].

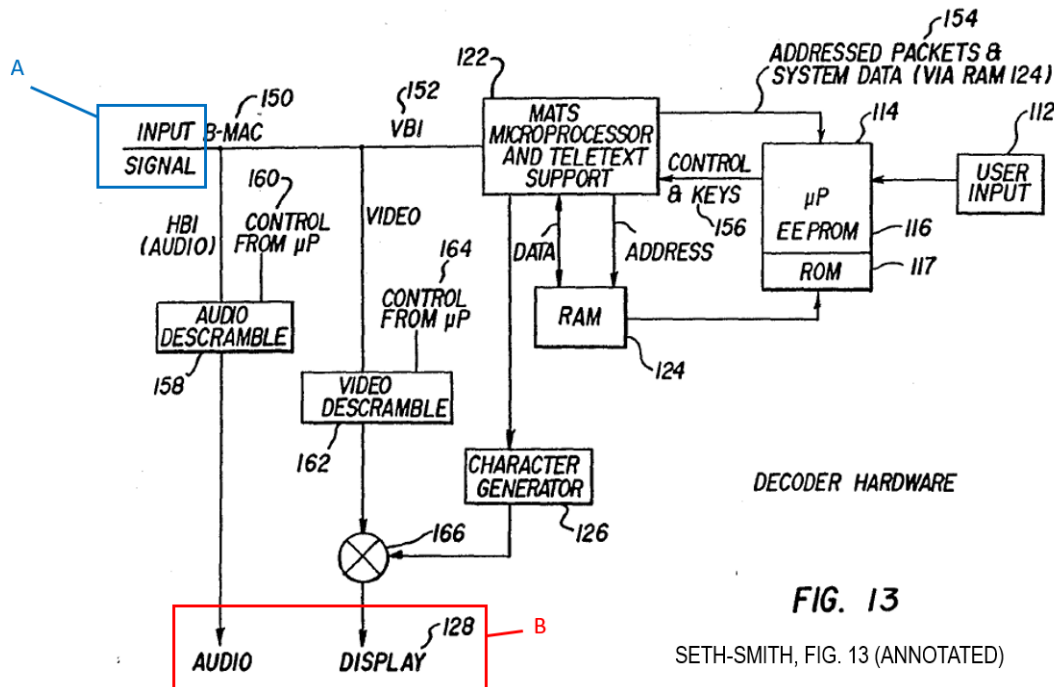


FIG. 13
SETH-SMITH, FIG. 13 (ANNOTATED)

58. The system includes an input signal provided at (A) that is processed by a decoder of a receiver (B) of a television system [Seth-Smith at FIG. 13].

59. Seth-Smith teaches that the input signal includes “teletext, video, and audio signal” that is “encrypted and/or scrambled” [Seth-Smith at 6:3-64]. The signal includes television frames that contain system data “necessary for operation of a subscription television system,” as well as “data needed for the operation of individual decoders and for transmission of messages to individual subscribers” [Seth-Smith at 7:23-45]. This information provides an “indication of the tier to which [a] program being transmitted on a particular channel at that time belongs,” and allows “individual decoders to use the tier number transmitted” to “either

enable or disable the viewing of a particular program at a particular time” [Seth-Smith at 10:43-68].

60. APOSITA would have found it obvious to interpret features of Block’s system based on the teachings of Seth-Smith. As I have discussed above, Seth-Smith teaches a television system for distributing protected program material that includes “a transmitter including a data insertion circuit for inserting a control bit in a transmitted signal comprising other control data and the protected program material” [Seth-Smith at Abstract]. Because Block describes scrambled audio and video signals highly similar to the protected television signals of Seth-Smith, APOSITA would have understood that the scrambled audio and video television signals of Block could be interpreted in view of the teachings of Seth-Smith [Seth-Smith at 7:5-45]. Accordingly, APOSITA would have found it obvious to interpret the program signals of Block as digital signals based on the teachings of Seth-Smith, as I discuss in detail below.

VII. Discussion of Prior Art and the Claims of the ’885 Patent

61. As I will discuss below, at ¶¶ 65-67, 74-81, 88-91, 97-101, 107-109, 112-113, 120-122, 126-127, and 132-135, all of the elements of claim 1 of the ’885 Patent are rendered obvious by Mustafa.

62. Moreover, as I will discuss below at ¶¶ 68-73, 82-87, 92-96, 102-106, 110-111, 114-119, 123-125, 128-131, and 136-138, all of the elements of claim 1

of the '885 Patent are rendered obvious by Campbell-1A, Campbell-1B, and Campbell-1C.

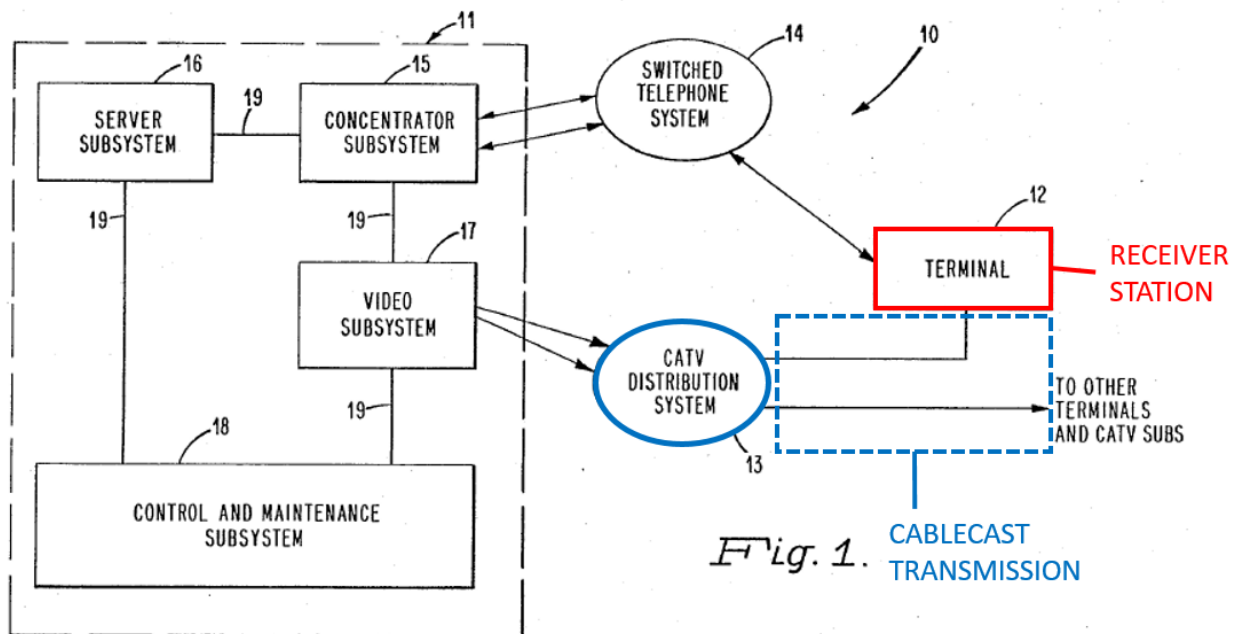
63. Further, as I will discuss below at ¶¶ 139-259, one of ordinary skill would have incorporated the teaches of Seth-Smith into Block, and the combination of Block with Seth-Smith renders obvious all of the elements of claims 102, 105, and 106 of the '885 Patent.

64. Below, I provide a detailed discussion of each element of claims 1, 102, 105, and 106 of the '885 Patent.

“1. A method of controlling the communication of signals at a receiver station, said receiver station comprising” (element 1.0)

65. In view of the knowledge of one of ordinary skill, Mustafa renders obvious element 1.0 (the preamble) of claim 1.

66. Mustafa discloses to one of ordinary skill a telecommunication system that includes a terminal of a wired television system [generally, Mustafa at Abstract and FIG. 1]. Because the terminal receives cablecast signals through a CATV distribution system, the wired television system of Mustafa is “a receiver station.” [Mustafa at Abstract, FIG. 1]. FIG. 1 of Mustafa shows an exemplary terminal, labeled with reference number 12 within the system taught by Mustafa.



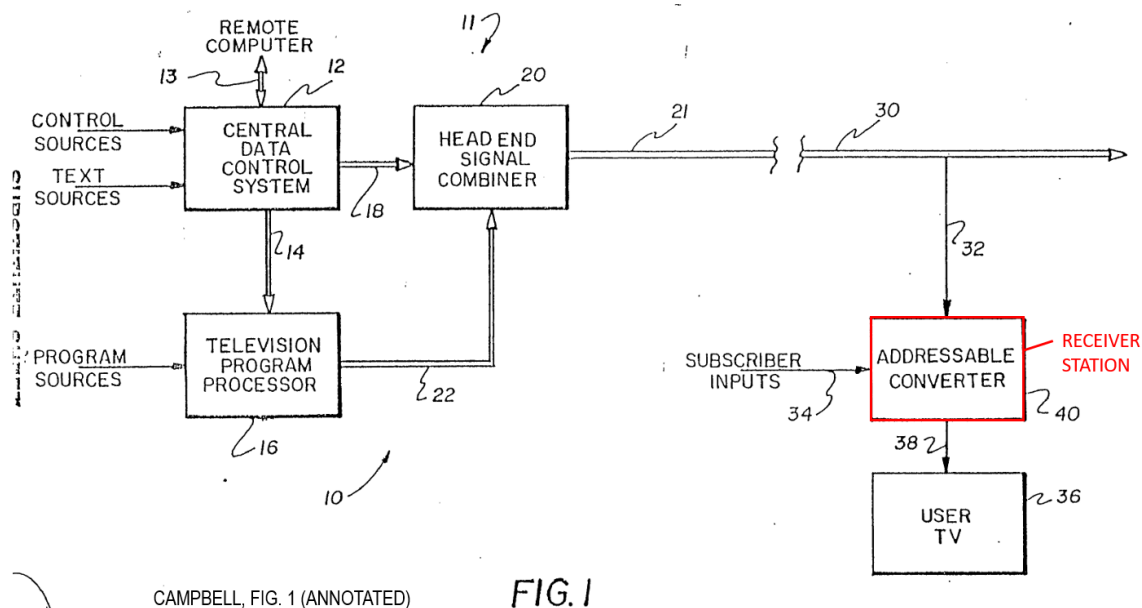
MUSTAFA, FIG. 1 (ANNOTATED)

67. Through its description of the interaction between the terminal 12 [“said receiver station”] and the CATV distribution system 13 which “synchroniz[es] a digital bit stream sent from a central facility” and provided through the CATV distribution system 13 “to a terminal on lines of television frames,” Mustafa at least renders obvious performing a method for controlling the communication of signals at a receiver station [Mustafa at Abstract, FIG. 1].

68. As I have discussed above at ¶¶ 44-48, Campbell-1A describes a “cable television system” that includes “an intelligent addressable converter designed to convert and descramble video” [Campbell-1A at 3:28-4:9 (emphasis added); Campbell-1B at 2:53-3:7; and Campbell-1C at 3:10-27]. Each addressable

converter “uses a graphics display generator” to generate display signals to present data on a “television receiver” [Campbell-1A at Abstract; Campbell-1B at Abstract; Campbell-1C at Abstract].

69. FIG. 1 of Campbell-1A, which I have annotated, illustrates the addressable converter, labeled with the reference number 40, within the system taught by Campbell-1A [Campbell-1A at FIG. 1; Campbell-1B at FIG. 1; Campbell-1C at FIG. 1].



70. APOSITA would have understood that, because addressable converter 40 of Campbell-1A receives “transmitted signals ... on a one-way data bus,” it is a receiver station [Campbell-1A at 6:30-35; Campbell-1B at 4:49-55; Campbell-1C at 5:22-27].

71. Campbell-1A further describes that the addressable converter “receives control data which allows the system operator to control subscription television services” by “controlling access to a wide range of television program and data signals” [Campbell-1A at 3:28-4:9; Campbell-1B at 2:53-3:7; Campbell-1C at 3:10-27].

72. APOSITA would have understood that controlling access to a signal would control communication of the signal. Furthermore, APOSITA would have understood that if access to a signal is denied, the signal would not be communicated to the device requesting access to the signal. APOSITA would have understood, conversely, that if access to a signal is granted, the signal would be communicated to the device requesting access to the signal. Thus, through its description of controlling access to television program and data signals, Campbell-1A describes controlling the communication of signals.

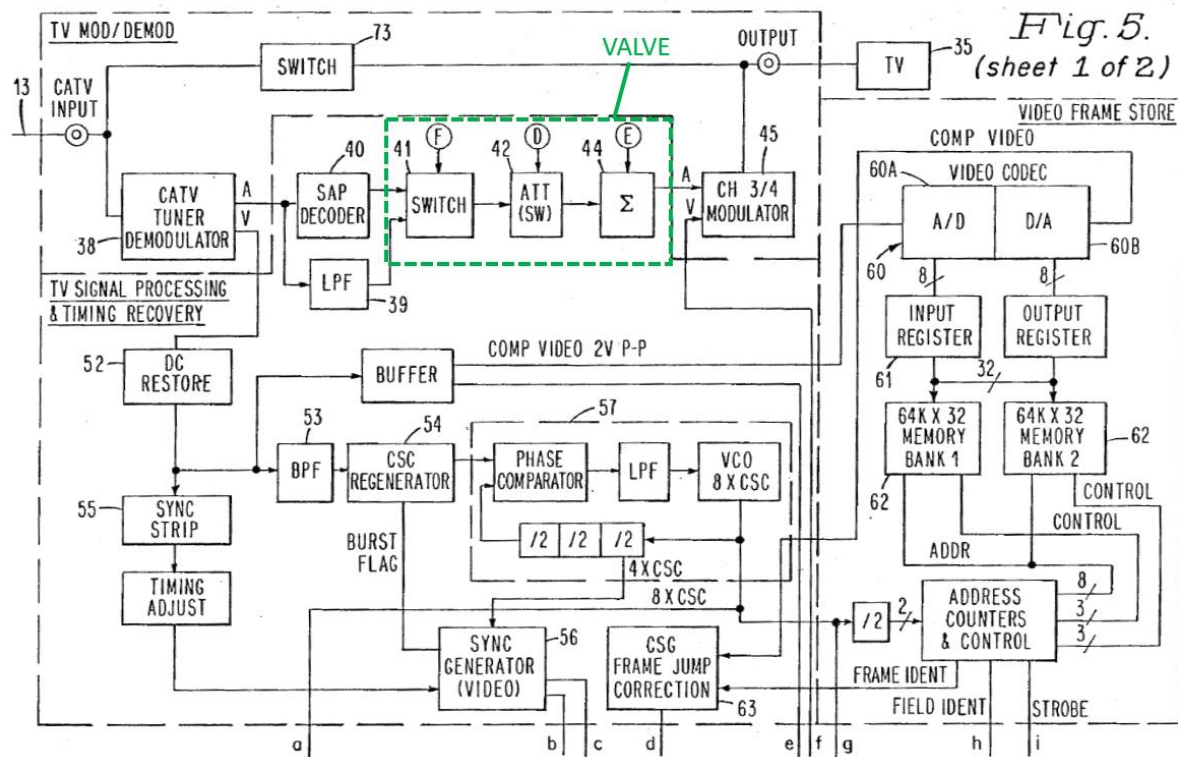
73. Therefore, through its description of controlling access to television program and data signals using an addressable converter [“a receiver station”] Campbell-1A at least renders obvious controlling the communication of signals at a receiver station [Campbell-1A at 3:28-4:9; Campbell-1B at 2:53-3:7; Campbell-1C at 3:10-27].

“(i) a valve for receiving and controlling the communication of signals and” (element 1.1)

74. In the view of the knowledge of one of ordinary skill, Mustafa renders obvious element 1.1 of claim 1.

75. As I have discussed above at ¶ 38, “valve” should be construed as a “device that regulates the flow of information” [’885 Patent at 36:1-22 (valve that receives and outputs information)]. As explained below, by its description of switch 41, switched attenuator 42, summer 44, and other related components, Mustafa renders obvious such a device [Mustafa at 6:49-7:3, FIG. 5 sheet 1].

76. Mustafa’s FIG. 5 sheet 1, which I have annotated, illustrates a detailed view of the terminal 12 [“said receiver station”] [Mustafa at FIG. 5 sheet 1]. The portion of the system within FIG. 5 sheet 1’s dotted lines is part of a set-top module 33 that “contains hardware and software for data communications to and from the Central Facility 11 and for receiving and processing video frames and audio frames sent from the Central Facility and delivering them to the television receiver 35” [Mustafa at 2:29-61 (emphasis added)].



MUSTAFA, FIG. 5 sheet 1 (ANNOTATED)

77. Mustafa also discloses that the CATV Tuner Demodulator 38 has two outputs, one labeled “A” (for audio), and the other labeled “V” (for video). With respect to audio, Mustafa discloses that

The system preferably has two types of audio: continuous and specific, both of which may be played simultaneously. Continuous audio is sent on a real time basis on, for example, audio channels. An example of continuous audio is background music. Specific audio is so called because it is specific to the displayed still frame. Typical specific audio is voiced narrative or instructions. Specific audio is intended for only certain selected terminals at a time and is sent in time-compressed bursts by addressed frames having the same address as the accompanying video frame. Only one channel of time-compressed audio is carried in an audio frame [Mustafa at 3:21-32].

78. In my opinion, it would be at least obvious in light of Mustafa that both types of audio in Mustafa can be provided along the path labeled “A” to the SAP Channel Decoder 40 and low pass filter 39. This is consistent with the understanding of a POSITA that content should be provided to the decoder appropriate to the content. For example, Henri Mertens and David Wood, “The EBU C-MAC/Packet System for Direct Broadcasting by Satellite” IEEE Journal on Selected Areas in Communications, Vol. SAC-3, No. 1, January 1985 (“Mertens”) explains that, in a system in which both video and audio are transmitted, “[a]t the receiver, the packets are steered, by address recognition, to the appropriate decoders.” [Mertens at 70]. Consistent with this understanding of the art, a POSITA would understand that in a system based on Mustafa, audio of multiple types can be provided along the path labeled “A” (starting at the CATV Tuner Demodulator 38 output) in FIG. 5 of Mustafa. Furthermore, APOSITA would understand that the audio frames of Mustafa would not be provided along the path labeled “V” to dc restore 52. A DC restore is used to rectify AC video signals to provide truer colors, and does not operate on audio signals. Therefore, APOSITA would have found it obvious that the audio frames of Mustafa are provided along the path labeled “A” to the SAP Channel Decoder 40 and low pass filter 39.

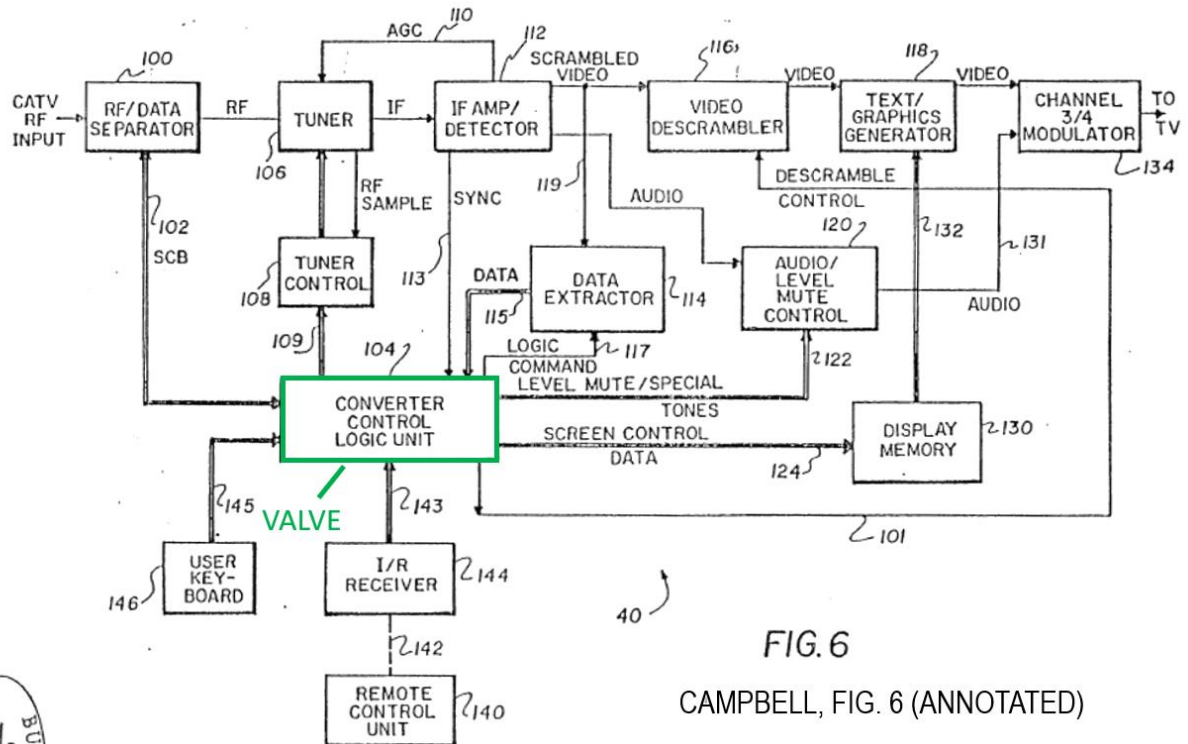
79. As Mustafa further discloses, the terminal 12 [“said receiver station”] includes switch 41, which receives an “incoming signal” from a demodulator and “select[s] [a] desired continuous audio signal” from the received “audio channels extracted from the audio output” of the demodulator [Mustafa at 6:23-7:3 (emphasis added)]. The selected channel is communicated to switched attenuator 42, summer 44, and then modulator 45 for further processing [Mustafa at 6:23-7:3]. The processed signal is then coupled “to television set 35 for playing” [Mustafa at 6:23-7:3].

80. Switch 41 is “controlled by a control signal from the Central Facility 11” through a “selection code stripped from a [video or audio] frame” [Mustafa at 6:23-7:3].

81. APOSITA would have recognized that because switch 41, attenuator 42, and summer 44 collectively receive an incoming signal, select a desired portion of the incoming signal for transmission and provide the signal to modulator 45 for processing, the collective logic of Mustafa’s system labelled as “valve” in annotated FIG. 1 above, including switch 41, attenuator 42, and summer 44, regulates the flow of information, is a valve for receiving and controlling the communication of signals [Mustafa at 6:23-7:3].

82. With respect to Campbell-1A, FIG. 6 of Campbell-1A, which I have annotated, illustrates a detailed view of the addressable converter [“said receiver

station”], which includes logic that controls television programming access of subscribers of the system taught by Campbell:



83. Converter control logic 104 receives “subscriber control data” and “makes several comparisons between the subscriber addressing data which describes the converter authorization and the channel control word which describes the required authorization for the television program currently being transmitted on the selected channel” [Campbell-1A at 22:30-24:17; Campbell-1B at 15:16-16:24; Campbell-1C at 21:1-22:25].

84. Based on these comparisons, converter control logic 104 determines whether to generate “an appropriate message for display on the television set of the

user” by directing “screen control data” to “a display memory 130” or instead to enable a video descrambler to “process the video signal of the selected television program” and an audio control unit to “transmit the audio signal to the television set” [Campbell-1A at 14:1-13, 22:30-24:17; Campbell-1B at 9:27-33, 15:16-16:24; Campbell-1C at 12:1-12, 21:1-22:25].

85. APOSITA would have known that, because converter control logic 104 regulates subscription television services, which are information, Campbell-1A renders obvious a valve through its description of converter control logic 104 [Campbell-1A at 22:30-24:17; Campbell-1B at 15:16-16:24; Campbell-1C at 21:1-22:25].

86. Indeed, converter control logic 104 operates in a highly similar manner to the “EOFS valve” described in the ’885 Patent, which is embodied as a programmable device having a “particular dedicated capacity” for detecting “end of file signals” [’885 Patent at 35:34-38:9]. The EOFS valve compares received “inputted binary information” to “signal word[s]” stored within the valve to determine whether to “inform[] said external transferring apparatus ... that said valve is ready to receive next signal word information” [’885 Patent at 35:34-38:9]. Correspondingly, converter control logic 104 compares received “control data” to “control word[s]” to determine whether to inform display memory 130 to format display characters for output at a television set of a user [Campbell-1A at 14:1-13,

22:30-24:17; Campbell-1B at 9:27-33, 15:16-16:24; Campbell-1C at 12:1-12, 21:1-22:25].

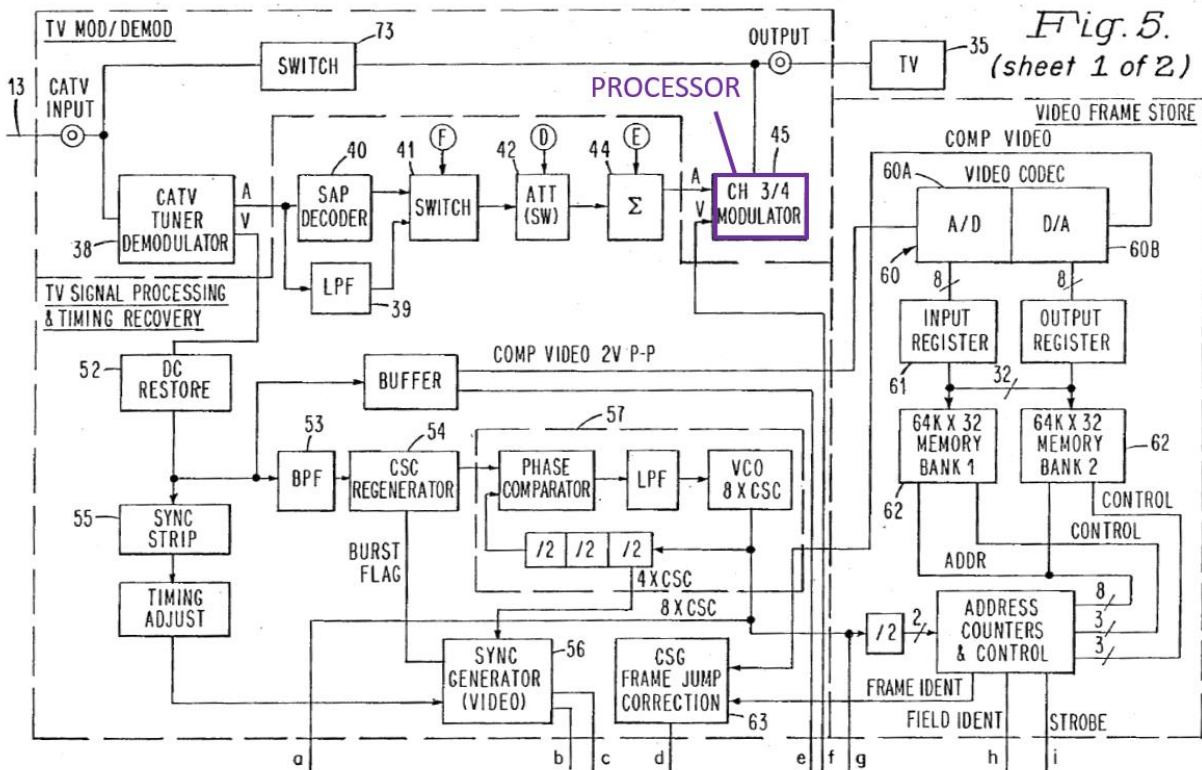
87. Thus, through its description of converter control logic 104, which regulates the transmission and reception of subscription television services, Campbell-1A renders obvious a valve for receiving and controlling the communication of signals.

“(ii) at least one processor that processes said signals, said method comprising the steps of:” (element 1.2)

88. As I have discussed above at ¶¶ 39-43, “processor” should be construed broadly enough to include “a device or module that operates on analog or digital signals” [’885 Patent at 135:52-56 (decoders 30 and 40 that process information) and 76:11-13 (buffers/comparators 8 that process information)]. By its description of modulator 45 and of microprocessor 67, Mustafa discloses two such devices [Mustafa at 6:49-8:68 and FIG. 5 sheet 1, sheet 2].

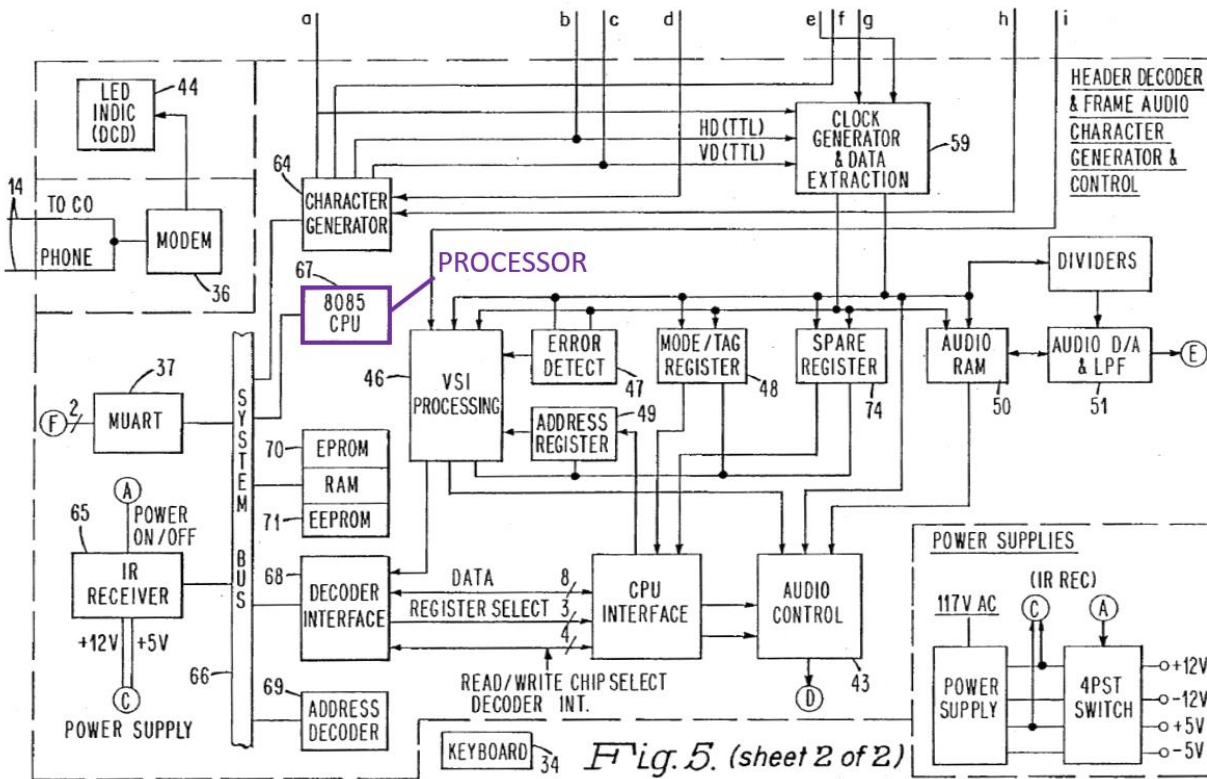
89. As I have discussed above at ¶¶ 49-52, Mustafa’s set-top module 33 is a part of terminal 12 that “contains hardware and software ... for receiving and processing video frames and audio frames sent from the Central Facility and delivering them to the television receiver 35” [Mustafa at 2:29-61]. FIG. 5 sheet 1 of Mustafa illustrates that Mustafa’s set-top box module 33 includes, for example, modulator 45 [“at least one processor”], which modulates signals input through its

“audio input” and “video input” [Mustafa at 7:38-8:43]. APOSITA would have understood that because modulator 45 operates on information in the form of audio and video input signals received by the terminal 12, it is a processor.



MUSTAFA, FIG. 5 sheet 1 (ANNOTATED)

90. FIG. 5 sheet 2 continues a detailed illustration of the terminal 12 [“said receiver station”], which Mustafa describes as being “controlled by microprocessor 67” [“at least one processor”] [Mustafa at 8:66-67]. In more detail, Mustafa’s microprocessor 67 operates on information received by terminal 12, and is, therefore, a processor.

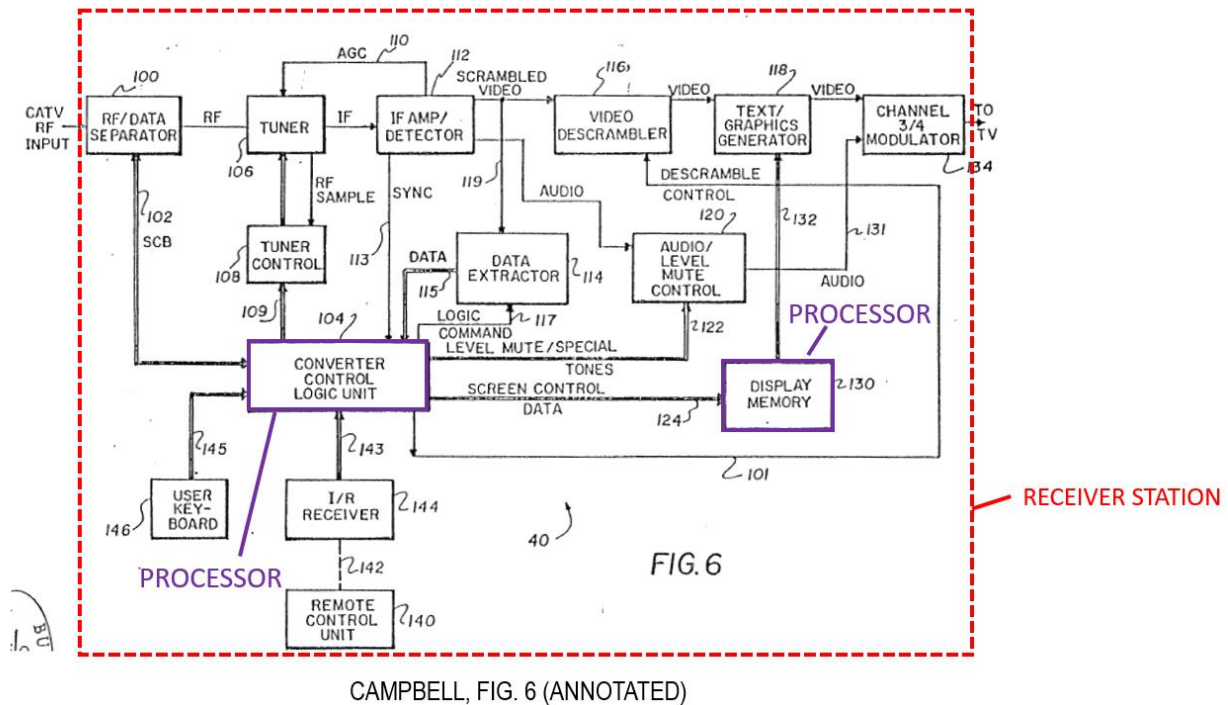


MUSTAFA, FIG. 5 sheet 2 (ANNOTATED)

91. Thus, through its descriptions of modulator 45 and microprocessor 67, Mustafa at least renders obvious at least one processor that processes signals, the communication of which are controlled by a valve.

92. As I have discussed above at ¶¶ 39-43, a “processor” should be construed broadly enough to include “a device or module that operates on analog or digital signals” [’885 Patent at 135:52-56 (decoders 30 and 40 that process information), 76:11-13 (buffers/comparators 8 that process information)]. FIG. 6 of Campbell-1A, which I have annotated, illustrates a detailed view of the

addressable converter 40 [“said receiver station”], which includes converter logic unit 104 and display memory 130.



93. Campbell-1A describes that the addressable converter 40 receives television signals from the head end signal combiner 20 of a central broadcasting station, and provides video and audio output for display on a connected television set [Campbell-1A at 12:32-13:9; Campbell-1B at 8:46-62; Campbell-1C at 11:1-14]. The television signals [“said signals”] are processed “under direction of converter control logic [104]” [Campbell-1A at 12:32-13:9; Campbell-1B at 8:46-62; Campbell-1C at 11:1-14]. Converter control logic 104 controls the descrambling of scrambled video signals within the television signals [Campbell-1A at 12:32-13:9; Campbell-1B at 8:46-62; Campbell-1C at 11:1-14]. Campbell-

1A describes that addressable converter 40 can “select[] a given channel and determine[] access to a given program” [Campbell-1A at 22:16-19 (emphasis added); Campbell-1B at 14:67-15:2; Campbell-1C at 20:18-21].

94. For example, in response to “the user entering a new channel number” on a keyboard, converter control logic 104 “implements several preparatory steps in the converter,” e.g., switching display modes, adjusting audio signals, and controlling the tuner 106 to “retune to the requested channel,” and controlling the data extractor 114 to “separate[] out the data transmitted on the vertical interval of the selected television signal” [Campbell-1A at 22:19-29 (emphasis added); Campbell-1B at 15:3-15; Campbell-1C at 20:21-31]. Converter control logic 104 also directs “screen control data,” e.g., “display characters and graphical symbols,” to display memory 130, which sends “formatted display characters” to text/graphics generator 118 [Campbell-1A at 14:1-13; Campbell-1B at 9:27-33; Campbell-1C at 12:1-12]. Text/graphics generator 118 then generates the data for output [Campbell-1A at 14:1-13; Campbell-1B at 9:27-33; Campbell-1C at 12:1-12].

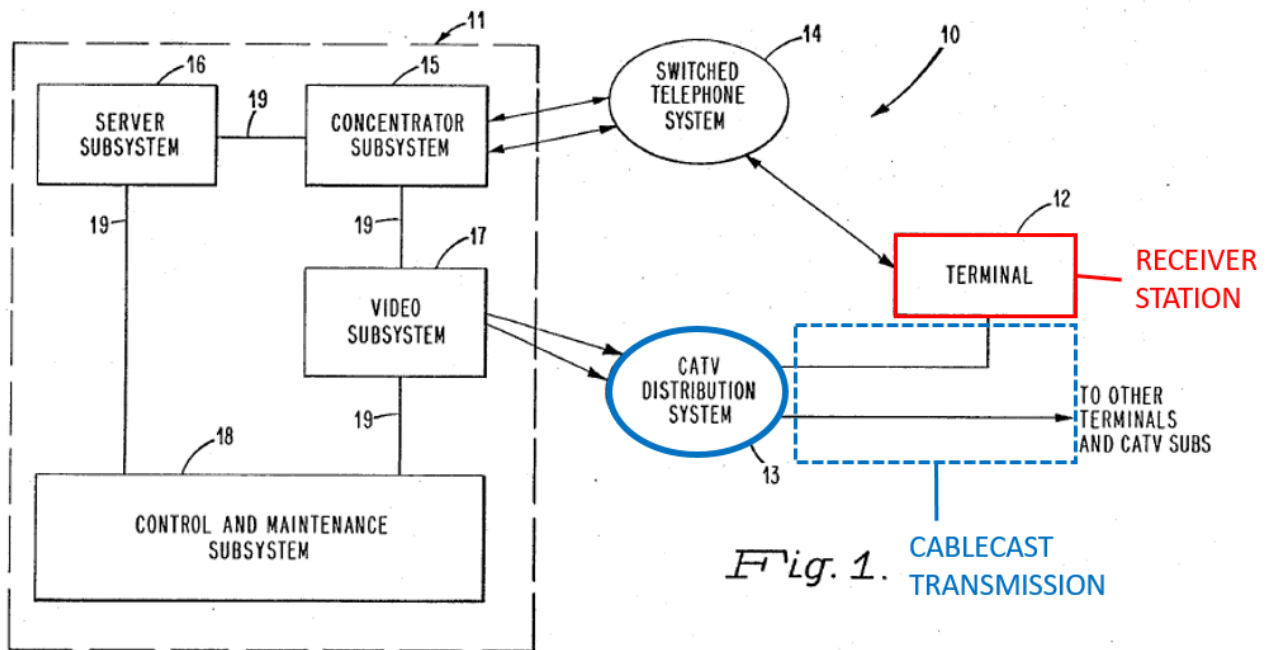
95. APOSITA would understand that, because converter control logic 104 processes television signals and controls the descrambling of the television signals, converter control logic 104 is a processor [Campbell-1A at 12:32-13:9; Campbell-1B at 8:55-62; Campbell-1C at 11:1-14]. Furthermore, APOSITA would

understand that, because display memory 130 receives and processes screen control data to provide “formatted display characters” to text/graphic generator 118, display memory 130 is also a processor [Campbell-1A at 14:1-13; Campbell-1B at 9:27-33; Campbell-1C at 12:1-12].

96. Thus, Campbell-1A at least renders obvious at least one processor that processes said signals [Campbell-1A at 12:32-13:9, 14:1-13, 22:19-29; Campbell-1B at 8:55-62, 9:27-33, 15:3-15; Campbell-1C at 12:1-12, 11:1-14, 20:21-31].

“receiving one of a broadcast transmission and a cablecast transmission that includes an information transmission that includes embedded signals;” (element 1.2.1)

97. Mustafa describes that “[a] Central Facility 11 is coupled to a plurality of terminals 12 [“said receiver station[s]”] through a first transmission medium 13” that “may be cable, such as a CATV network” [Mustafa at 2:64-3:2]. FIG. 1, which I have annotated, illustrates an exemplary terminal 12 “receiving and processing video frames and audio frames sent from the Central Facility [11]” [Mustafa at 6:23-41].



MUSTAFA, FIG. 1 (ANNOTATED)

98. Mustafa describes that Central Facility 11 “provides both video and audio information” to terminal 12 through the CATV distribution system [Mustafa at 2:64-3:19]. APOSITA would have understood that because this video and audio information is transmitted over a CATV network, it is a cablecast transmission.

99. Additionally, Mustafa describes that the video and audio information includes a “composite signal [that] contains video frames, digitally encoded audio frames, and BTSC encoded audio channels” [Mustafa at 6:42-48]. The composite signal includes video frames, audio frames, and audio channels, all of which are information; therefore, the composite signal is an information transmission [Mustafa at 2:64-3:2, 6:23-48].

100. Furthermore, APOSITA would have understood that because the video frames, digitally encoded audio frames, and encoded audio channels, are contained within the composite signal [“an information transmission”], these components of the composite signal are embedded in the composite signal [Mustafa, 2:64-3:2, 6:23-48].

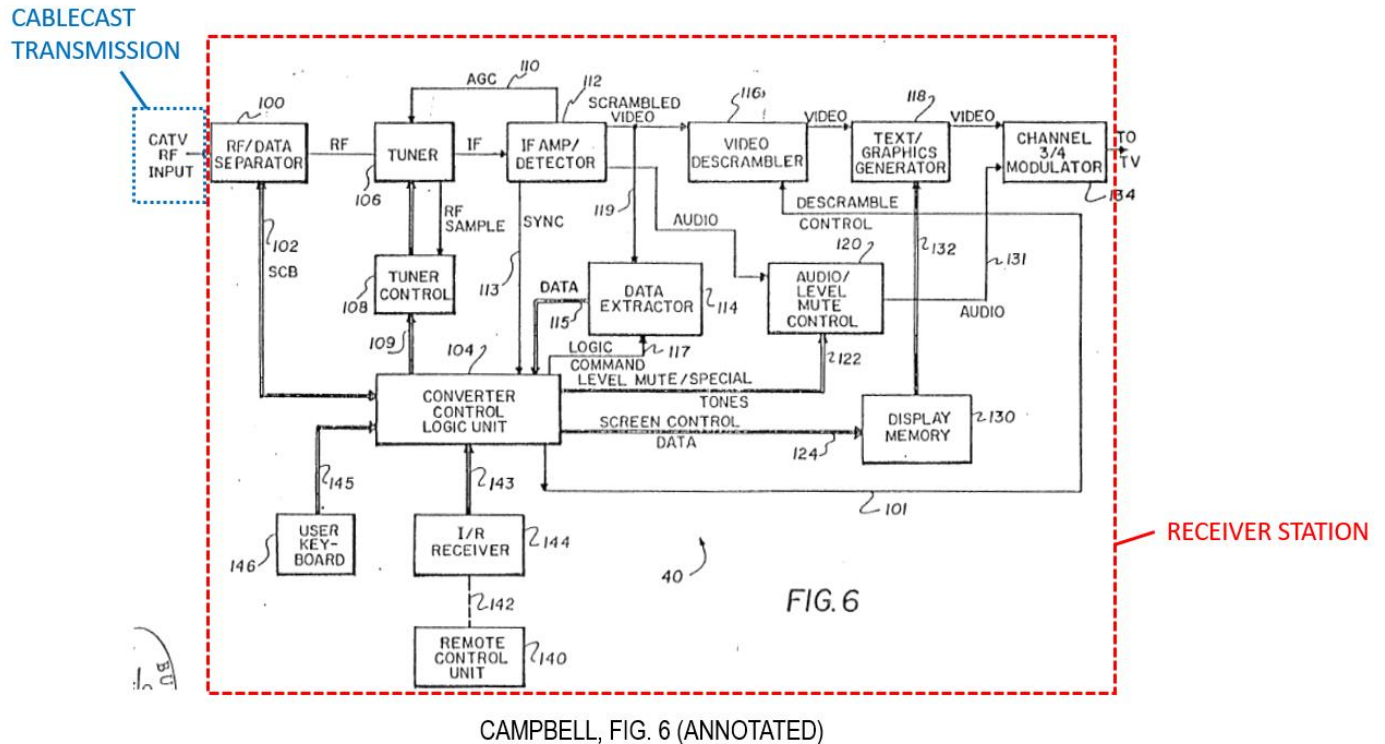
101. Thus, through its description of terminal 12 which receives video and audio information [“a cablecast transmission”] including a composite signal [“an information transmission”] that contains video frames, audio frames, and audio channels [“embedded signals”] through a CATV network, Mustafa at least renders obvious receiving a cablecast transmission that includes an information transmission that includes embedded signals [Mustafa at 2:64-3:19, 6:23-48].

102. Campbell-1A teaches that addressable converter 40, including converter control unit 104 [“at least one processor”] and display memory 130 [“at least one processor”], is capable of receiving television signals from head end station 11 [Campbell-1A at FIG. 1, 6:10-14; Campbell-1B at FIG. 1, 4:24-49; and Campbell-1C at FIG. 1, 5:1-6].

103. Campbell-1A further teaches that head end station 11 includes central data system 12 that “gathers data from a wide variety of sources and formats the data for transmission on video frequency channels” [Campbell-1A at FIG. 1, 6:10-14; Campbell-1B at FIG. 1, 4:24-49; and Campbell-1C at FIG. 1, 5:1-6]. “The

formatted data is then transmitted by communications link 14 to a television program processor where it is incorporated into the vertical blanking intervals of video signals generated by a variety of television program sources” [Campbell-1A at FIG. 1, 6:10-14; Campbell-1B at FIG. 1, 4:24-49; Campbell-1C at FIG. 1, 5:1-6]. A “combined cable television and data signal” is transmitted to various remote receivers, including the addressable converter 20 [Campbell-1A at FIG. 1, 6:10-14; Campbell-1B at FIG. 1, 4:24-49; and Campbell-1C at FIG. 1, 5:1-6]. APOSITA would have understood that, because the combined cable television and data signal contains cable television information, the combined cable television and data signal is a cablecast transmission [Campbell-1A at FIG. 1, 6:10-14; Campbell-1B at FIG. 1, 4:24-49; and Campbell-1C at FIG. 1, 5:1-6].

104. FIG. 6, which I have annotated, illustrates that addressable converter 40, “under direction of converter control logic, processes the RF data-loaded television signals from combined video output line 21 of head end signal combiner 20 and provides video and audio output for a television set” [Campbell-1A at 12:32-13:9 (emphasis added); Campbell-1B at 8:46-62; Campbell-1C at 11:1-14]. “The RF output signals” are used to “provide a scrambled base-band video signal and a separate audio signal [“an information transmission”]” [Campbell-1A at 13:10-15; Campbell-1B at 8:63-92; Campbell-1C at 11:15-20].

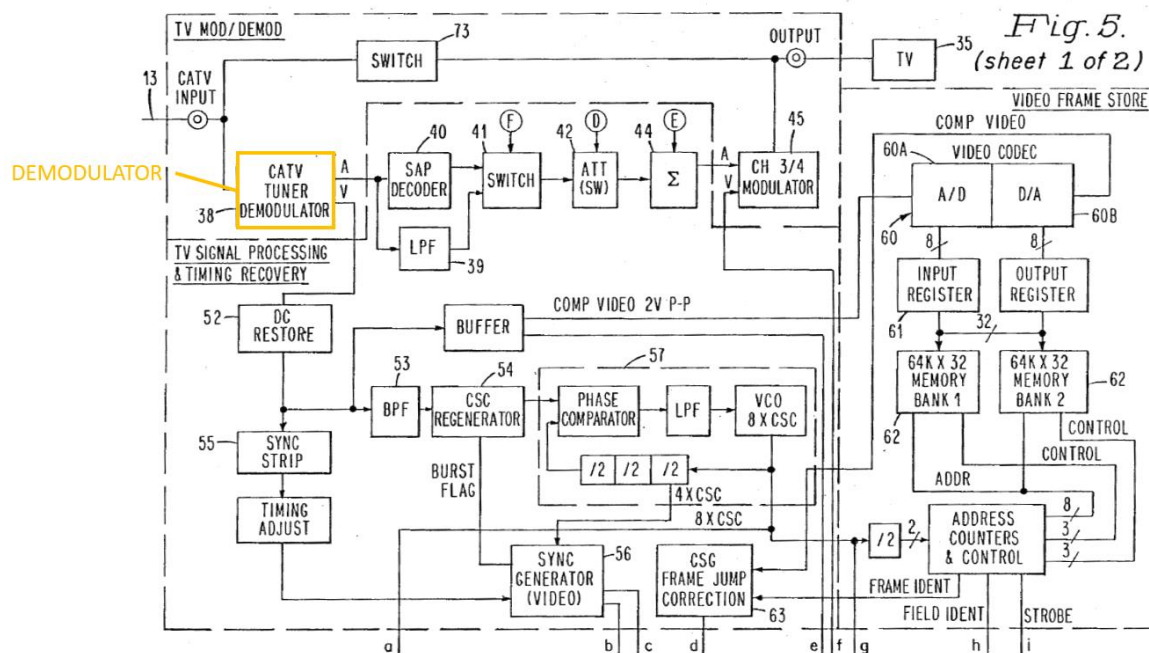


105. Campbell-1A also describes that the “data transmitted on the vertical interval of the television signals,” e.g., scrambled video signals, includes embedded “text data,” and “control data” such as “subscriber addressing data” and “channel control data” [“embedded data”] [Campbell-1A at 19:6-14; Campbell-1B at 12:58-68; Campbell-1C at 26:20-28].

106. Thus, by its description of the data-loaded television signals, Campbell-1A at least renders obvious receiving a cablecast transmission that includes an information transmission that includes embedded signals [Campbell-1A at 12:32-13:9; Campbell-1B at 8:46-62; Campbell-1C at 11:1-14].

“demodulating said one of a broadcast transmission and a cablecast transmission to detect said information transmission therein;” (element 1.2.2)

107. As I have discussed above at ¶¶ 97-101, Mustafa describes that terminal 12 receives video and audio information [Mustafa at 6:42-48]. This video and audio information is received by terminal 12 as an incoming signal [“said cablecast transmission”] that includes “a composite signal [“said information transmission”]” [Mustafa at 6:42-48]. Mustafa’s FIG. 1, which I have annotated, illustrates that the incoming signal is received by a CATV demodulator 38 of the terminal 12.



MUSTAFA, FIG. 5 sheet 1 (ANNOTATED)

108. The “CATV demodulator 38 receives a selected NTSC channel signal over the CATV network,” and “demodulates the incoming signal [“said cablecast transmission”] to baseband and splits the audio channels from the video and audio frames [collectively “said information transmission”]” [Mustafa at 6:42-48 (emphasis added)].

109. Thus, APOSITA would have understood that through its description of the demodulation of the incoming signal [“said cablecast transmission”] to baseband and detecting the video frames, digitally encoded audio frames, and encoded audio channels of the composite signal [“said information transmission”], in order to separate the audio channels from the video and audio frames, Mustafa at least renders obvious demodulating a cablecast transmission to detect an information transmission.

110. Campbell-1A describes that television signals [“said cablecast transmission”] received at the addressable converter 40 are “input to an RF/data separator 100” [Campbell-1A at 12:32-13:9, FIG. 6; Campbell-1B at 8:46-62, FIG. 6; Campbell-1C at 11:1-14, FIG. 6]. “The RF data-loaded television signals are input to a conventional tuner 106,” which “us[es] a sliding band pass filter and a band switched front end” to generate RF output signals that are “detected by an IF/amp detector 112 to provide a scrambled base-band video signal and a separate audio signal [“said information transmission”]” [Campbell-1A at 12:32-13:15

(emphasis added); Campbell-1B at 8:46-92; Campbell-1C at 11:1-20]. APOSITA would have understood that by separating a received television signal into a base-band video signal and a separate audio signal, RF/data separator 100 and IF/amp detector 112 of the addressable converter 40 demodulate the received RF data-loaded television signals to detect scrambled video signals [“said information transmission”] [Campbell-1A at 12:32-13:15; Campbell-1B at 8:46-92; Campbell-1C at 11:1-20].

111. Thus, Campbell-1A at least renders obvious demodulating a cablecast transmission to detect an information transmission therein [Campbell-1A at 12:32-13:15; Campbell-1B at 8:46-92; Campbell-1C at 11:1-20].

**“detecting said embedded signals in said information transmission;”
(element 1.2.3)**

112. As I have discussed above at ¶¶ 97-101, Mustafa describes that the terminal 12 receives a cablecast transmission that includes “a composite signal [“said information transmission”]” that “contains video frames, digitally encoded audio frames, and BTSC encoded audio channels [each of which is one of the “said embedded signals”]” [Mustafa at 6:42-48]. As I have discussed above at ¶¶ 107-109, these video and audio frames and audio channels are contained within the composite signal; therefore, APOSITA would have understood that these data are embedded signals within the composite signal.

113. Through its description of the demodulation of “the incoming signal to baseband” and “split[ting] the audio channels from the video and audio frames [“said embedded signals”],” Mustafa describes detecting and extracting embedded components of the composite signal [“said information transmission”]. Thus, Mustafa at least renders obvious detecting the embedded signals [Mustafa at 6:42-48].

114. As I have discussed above at ¶¶ 102-106 and 110-111, Campbell-1A describes demodulating RF data-loaded television signals to detect scrambled video signals [“said information transmission”] [Campbell-1A at 12:32-13:15; Campbell-1B at 8:46-92; Campbell-1C at 11:1-20].

115. Campbell-1A also describes that “data transmitted on the vertical interval of the television signals,” e.g., scrambled video signals, includes embedded “text data,” and “control data” such as “subscriber addressing data” and “channel control data” [“embedded data”] [Campbell-1A at 19:6-14; Campbell-1B at 12:58-68; Campbell-1C at 26:20-28].

116. Data extractor 114 then extracts “a serial data stream . . . from the vertical interval of the scrambled video signal” [Campbell-1A at 13:16-27; Campbell-1B at 9:3-14; Campbell-1C at 11:21-27]. The data stream within the vertical stream of the scrambled video signal includes subscriber addresser data and channel control data [“said embedded data”] [Campbell-1A at 13:16-27;

Campbell-1B at 9:3-14; Campbell-1C at 11:21-27]. These data embedded within the scrambled video signals are illustrated in FIG. 11, which I have annotated, in “the form of data words” [Campbell-1A at 19:6-14; Campbell-1B at 12:58-68; Campbell-1C at 26:20-28].

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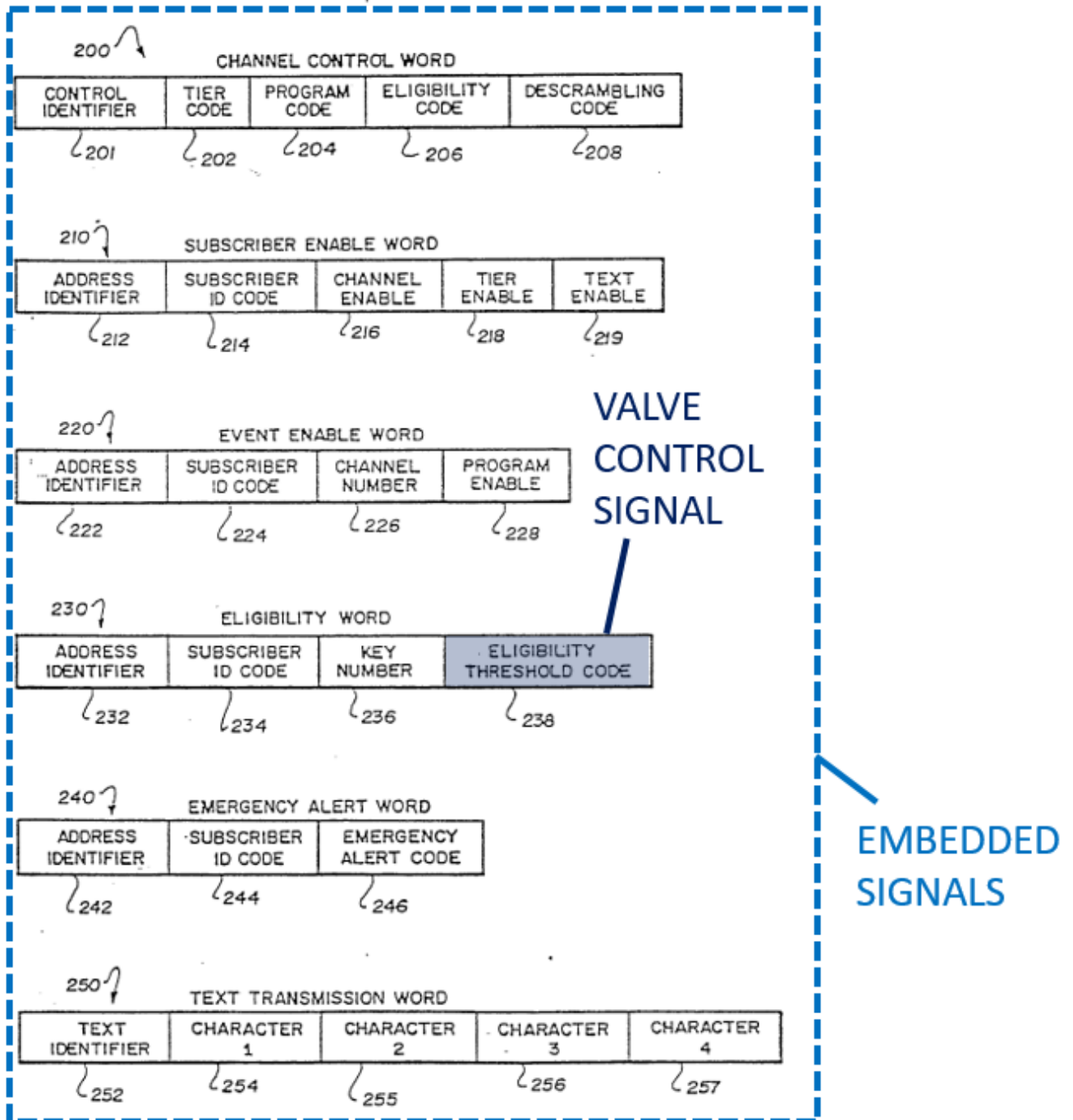


FIG. 11



CAMPBELL, FIG. 11 (ANNOTATED)

SAMSUNG-1003

117. Campbell-1A describes that “subscriber enable word 210” includes various codes, e.g., “subscriber identification code 214” and “channel enable code 216” that are “used by converter control logic 104 to determine whether the converter apparatus should be enabled for processing television signals to the television set” [Campbell-1A at 19:35-20:27; Campbell-1B at 13:25-60; Campbell-1C at 17:21-18:17]. Campbell-1A also describes that “eligibility word 230” includes “an eligibility threshold code 238” that is determined by an “authorized party” and “identifies certain eligibility codes 206 transmitted as part of channel control word 200 for certain television programs which require limited access” [Campbell-1A at 21:5-21; Campbell-1B at 14:9-28; Campbell-1C at 19:1-17]. The eligibility threshold is used by converter control logic 104 to determine whether to generate “an appropriate message for display on the television set of the user” by directing “screen control data” to “a display memory 130” [Campbell-1A at 14:1-13, 22:30-24:17; Campbell-1B at 9:27-33, 15:16-16:24; Campbell-1C at 12:1-12, 21:1-22:25].

118. The scrambled video signals [“said information transmission”] include embedded text data and control data [“embedded data”] [Campbell-1A at 19:35-20:27; Campbell-1B at 13:25-60; Campbell-1C at 17:21-18:17]. APOSITA would have understood that, because data extractor 114 extracts the subscriber addresser data and channel control data [“said embedded data”] from the

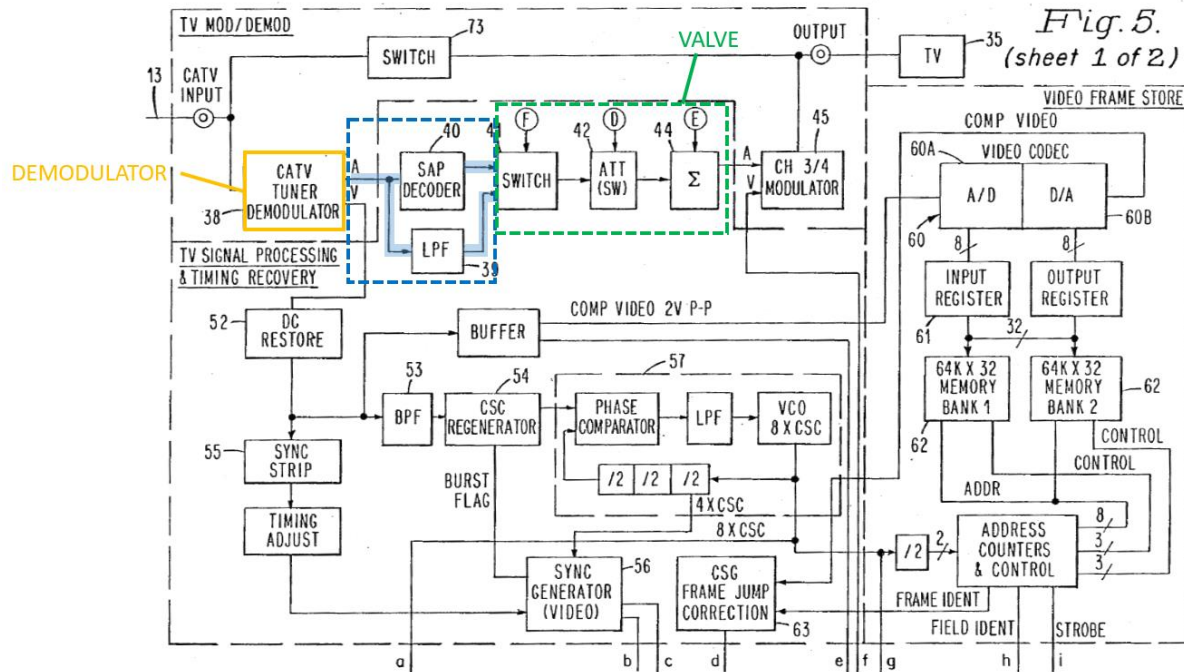
scrambled video signal [“said information transmission”], data extractor 114 detects embedded data within an information transmission.

119. Thus, through its description of extracting the control data from the scrambled video signals, Campbell-1A at least renders obvious detecting embedded signals in an information transmission [Campbell-1A at 13:16-27, 19:35-20:27; Campbell-1B at 9:3-14, 13:25-60; Campbell-1C at 11:21-27, 17:21-18:17].

“communicating said embedded signals to said valve;” (element 1.2.4)

120. As I have discussed above at ¶¶ 112-113, Mustafa describes detecting video frames, audio frames, and audio channels [“said embedded signals”] from a composite signal [“said information transmission”] [Mustafa at 6:42-48].

121. FIG. 5 sheet 1 of Mustafa, which I have annotated, illustrates that “[t]he audio channels [“said embedded signals”] extracted from the audio output of demodulator 38 are separated by a low-pass filter 39 and a SAP channel decoder 40” and “are connected into an analog switch 41” [Mustafa at 6:45-68 (emphasis added)].



MUSTAFA, FIG. 5 sheet 1 (ANNOTATED)

122. APOSITA would have found it obvious that connecting an output of a first device to a second device teaches communicating the output of the first device to the second device. Thus, through its description of the passing of audio channels extracted from the demodulator 38 to the switch 41, Mustafa at least renders obvious communicating embedded signals to a valve for receiving and controlling the communication of signals [Mustafa at 6:42-68].

123. As I have discussed above at ¶¶ 82-87, converter control logic 104 of Campbell-1A uses “the subscriber addressing data” to determine whether to generate “an appropriate message for display on the television set of the user” by directing “screen control data” to “a display memory 130” or instead to enable a

video descrambler to “process the video signal of the selected television program” and an audio control unit to “transmit the audio signal to the television set” [Campbell-1A at 14:1-13, 22:30-24:17; Campbell-1B at 9:27-33, 15:16-16:24; Campbell-1C at 12:1-12, 21:1-22:25].

124. As I have discussed above at ¶¶ 114-119, data extractor 114 of Campbell-1A extracts embedded “control data” such as “subscriber addressing data” and “channel control data” [“embedded data”], from a serial data stream [Campbell-1A at 19:6-14; Campbell-1B at 12:58-68; Campbell-1C, 26:20-28]. These control data are transmitted from data extractor 114 to converter control logic 104, as shown in the annotated version of FIG. 6 of Campbell-1A [Campbell-1A at 19:6-14, FIG. 6; Campbell-1B at 12:58-68, FIG. 6; Campbell-1C at 26:20-

28, FIG. 6].

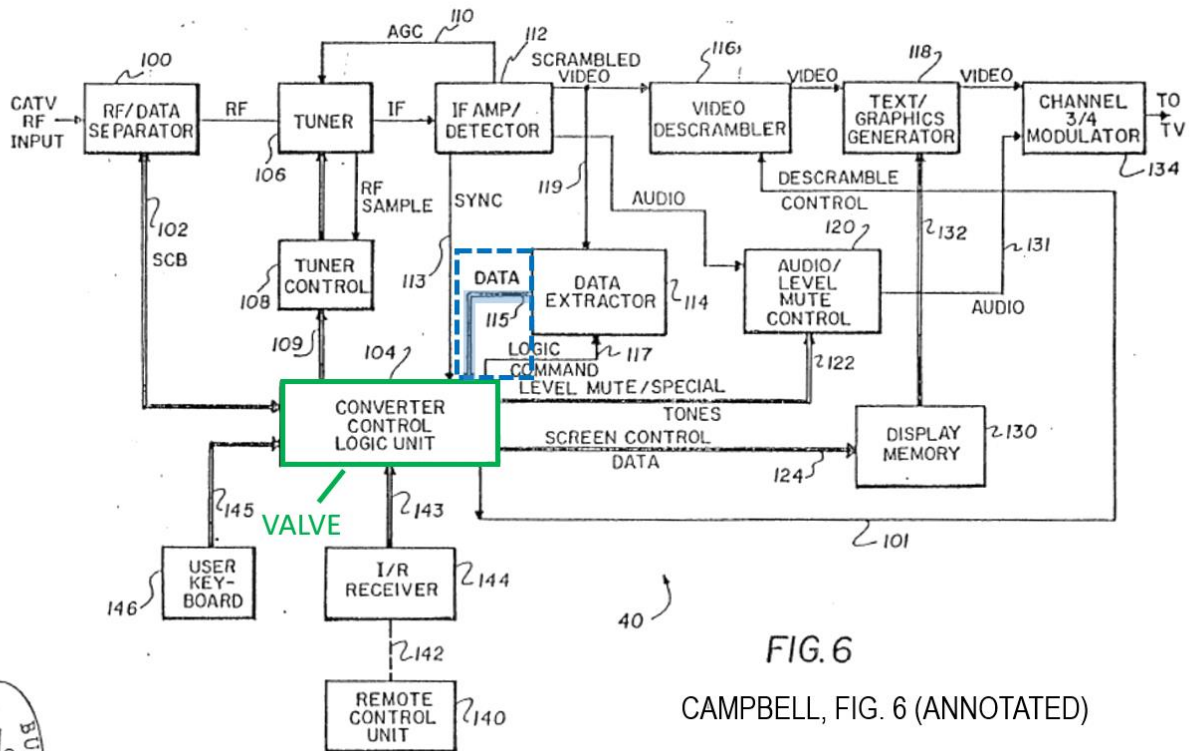


FIG. 6
CAMPBELL, FIG. 6 (ANNOTATED)

125. Thus, through its description of transmitting subscriber addressing data [“said embedded data”] from data extractor 114 to converter control logic 104 [“said valve”], Campbell-1A at least renders obvious communicating embedded signals to the valve for receiving and controlling communication of signals [Campbell-1A at 19:6-14, FIG. 6; Campbell-1B at 12:58-68, FIG. 6; Campbell-1C at 26:20-28, FIG. 6].

“detecting, at said valve, valve control signals that are embedded in said embedded signals; and” (element 1.2.5)

126. As I have discussed above at ¶¶ 120-122, Mustafa describes transmitting audio channels [“said embedded signals”] extracted from the demodulator 38 to switch 41 [Mustafa at 6:42-68]. “Preferably ... a selection code stripped from a [video or audio] frame [“said embedded signal”] controls switch 41” [Mustafa at 6:49-68]. APOSITA would understand that, because Mustafa’s selection code controls switch 41, which is a portion of the logic of Mustafa collectively construed as a “valve,” the selection code is a valve control signal. Through its description of receiving a selection code at the logic of Mustafa collectively construed as a “valve,” in response to which a portion of the logic of Mustafa collectively construed as a “valve”—switch 41—selects an audio channel, Mustafa renders obvious detecting valve control signals that are embedded in embedded signals received at the valve. [Mustafa at 6:49-68].

127. Thus, APOSITA would have understood that through its description of using a selection code from a video or audio frame embedded within a composite signal received by the terminal 12 to control the switch 41, Mustafa at least renders obvious detecting valve control signals that are embedded in signals received at the valve [Mustafa at 6:49-68].

128. As I have discussed above at ¶¶ 114-119 and 123-125, Campbell-1A describes data extractor 114, which extracts embedded “control data” such as “subscriber addressing data” and “channel control data” [“embedded data”], from a

serial data stream [Campbell-1A at 19:6-14; Campbell-1B at 12:58-68; Campbell-1C at 26:20-28]. These control data are transmitted from data extractor 114 to converter control logic 104 [Campbell-1A at 19:6-14; Campbell-1B at 12:58-68; Campbell-1C at 26:20-28].

129. Converter control logic 104 uses an eligibility threshold code 238 embedded within the control data to determine whether the “eligibility code threshold is exceeded” [Campbell-1A at 21:5-21, 22:30-24:17; Campbell-1B at 14:9-28, 15:16-16:24; Campbell-1C at 19:1-17, 21:1-22:25]. Based on this determination, converter control logic 104 controls components of addressable converter 40 to either generate “an appropriate message for display on the television set of the user” by directing “screen control data” to “a display memory 130” or instead to “process the video signal of the selected television program” and “transmit the audio signal to the television set” by enabling a video descrambler and an audio control unit [Campbell-1A at 14:1-13, 22:30-24:17; Campbell-1B at 9:27-33, 15:16-16:24; Campbell-1C at 12:1-12, 21:1-22:25].

130. A POSITA would have understood that, because converter control logic 104 receives the embedded control data and uses the control data to determine whether to direct “screen control data” to “a display memory 130,” or to provide control signals to enable a video descrambler and an audio control unit, the

control data are valve control signals [Campbell-1A at 14:1-13, 22:30-24:17; Campbell-1B at 9:27-33, 15:16-16:24; Campbell-1C at 12:1-12, 21:1-22:25].

131. Thus, through its description of receiving and operating in response to “control data,” Campbell-1A renders obvious detecting, at said valve, valve control signals that are embedded in said embedded signals [Campbell-1A at 19:6-14, 22:30-24:17; Campbell-1B at 12:58-68, 15:16-16:24; Campbell-1C at 26:20-28, 21:1-22:25].

“controlling said valve, in response to said valve control signals, so that said valve performs at least one of the functions of ceasing to communicate and commencing to communicate said embedded signals to said at least one processor.” (element 1.2.6)

132. As I have discussed above at ¶¶ 120-122 and 126-127, the logic of Mustafa collectively construed as “valve,” including switch 41, is controlled by “a selection code stripped from a frame” to “select the desired continuous audio signal,” which is “then connected into the audio input of a channel of modulator 45 which couples it to television set 35 for playing” [Mustafa at 6:49-7:3].

133. The desired continuous audio signal is selected from the audio channels [“said embedded signals”] split from the composite signal [“said information transmission”] by the demodulator 38 [Mustafa at 6:34-7:3]. Accordingly, APOSITA would have understood that Mustafa’s description of

selecting the desired continuous audio signal and subsequently connecting the continuous audio signal “into the audio input of a channel of modulator 45 [“said at least one processor”]” teaches selecting an embedded signal for communication to a processor [Mustafa at 6:42-48].

134. APOSITA would have understood that selecting a particular audio signal and transmitting the selected signal for playing on a device would commence to communicate the selected signal to the device on which the signal is played. Further, APOSITA would have understood that, if a signal different from the selected signal was previously being played at the device, transmitting the selected signal to the device for playing would cease to communicate the signal different from the selected signal and commence to communicate the selected signal.

135. Thus, through its description of using “a selection code [“said valve control signal”] obtained from a [video or audio] frame” to control “switch 41 [a portion of the logic of Mustafa collectively construed as a “valve”] to select the desired continuous audio signal [“said embedded signal”],” Mustafa at least renders obvious controlling a valve, in response to said valve control signals, so that said valve performs at least one of the functions of ceasing to communicate and commencing to communicate said embedded signals to said at least one processor [Mustafa at 6:49-68].

136. As I have discussed above at ¶¶ 82-87, 92-96, 102-106, 110-111, 114-119, 123-125, and 128-131, converter control logic 104 of Campbell-1A receives “subscriber control data” and “makes several comparisons between the subscriber addressing data which describes the converter authorization and the channel control word which describes the required authorization for the television program currently being transmitted” [Campbell-1A at 22:30-24:17; Campbell-1B at 15:16-16:24; Campbell-1C at 21:1-22:25].

137. As shown in FIG. 6 of Campbell-1A, an annotated version of which has been reproduced below, converter control logic 104 controls access to the television programming in response to the received subscriber control data by “direct[ing] screen control data ... to a display memory” for formatting [Campbell-1A at 14:1-13 (emphasis added); Campbell-1B at 9:27-33; Campbell-1C at 12:1-12]. As I have discussed above at ¶¶ 92-96, display memory 130 is a processor. Because the screen control data is part of the “control data” such as “subscriber addressing data” and “channel control data” [“embedded signals”], Campbell-1A renders obvious commencing to communicate embedded signals to a processor through its description of directing screen control data to display memory 130 [Campbell-1A at 14:1-13; Campbell-1B at 9:27-33; Campbell-1C at 12:1-12].

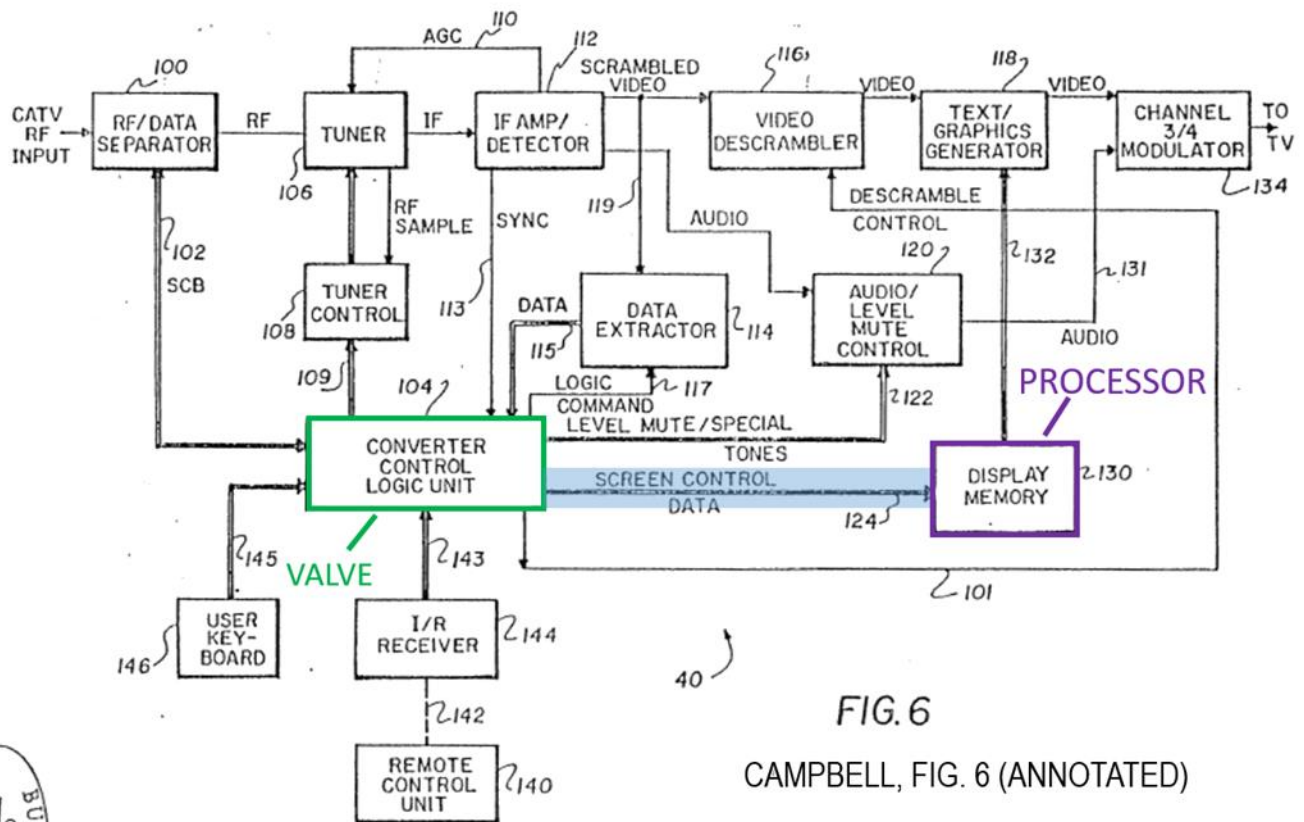
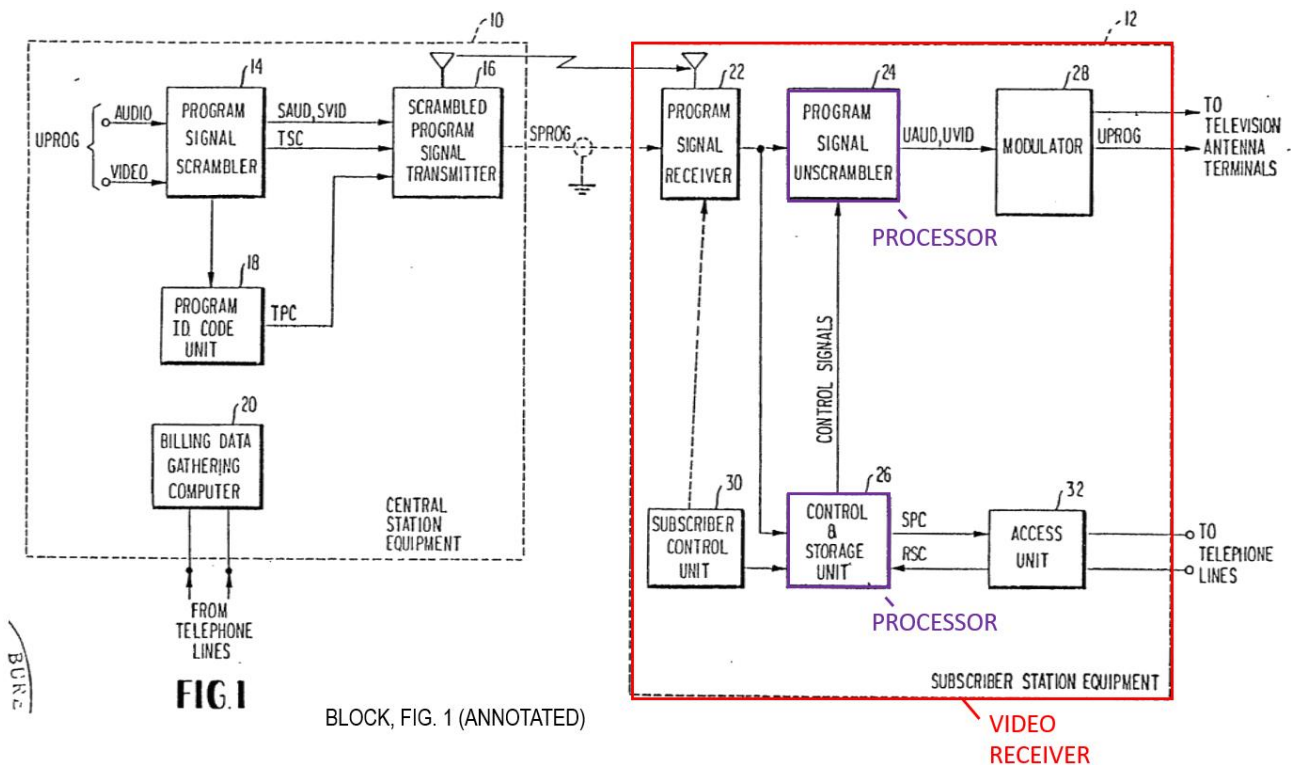


FIG. 6
CAMPBELL, FIG. 6 (ANNOTATED)

138. Thus, through its description of controlling converter control logic 104 to direct screen control data to display memory 130 in response to the received subscriber control data, Campbell-1A at least renders obvious controlling a valve, in response to said valve control signals, so that said valve performs at least one of the functions of ceasing to communicate and commencing to communicate said embedded signals to said at least one processor [Campbell-1A at 21:5-21, 22:30-24:17; Campbell-1B at 14:9-28, 15:16-16:24; Campbell-1C at 19:1-17, 21:1-22:25].

“A method of processing signals in a video receiver, said video receiver having a plurality of programmable processors, said method comprising the steps of:” (element 102.0)

139. Block describes a subscriber station that receives “program signals” that include “scrambled audio and video signals as well as various synchronizing signals and codes” [Block at 3:27-37]. APOSITA would have understood that, because Block’s subscriber station receives program signals including “scrambled audio and video signals,” the subscriber station is a video receiver [Block at 3:27-37 (emphasis added)]. FIG. 1 of Block illustrates subscriber station equipment, labeled with reference number 12, within the subscriber station taught by Block.



140. Program signals are transmitted to the subscriber station equipment 12 from “the central station equipment 10,” and “the received signal is supplied both to a program signal unscrambler 24 and to a control and storage unit 26” [Block at 3:62-4:9].

141. As I discussed above at ¶¶ 39-43 a “processor” should be construed broadly enough to include “a device or module that operates on analog or digital signals” [’885 Patent, 135:52-56 (decoders 30 and 40 that process information) and 76:11-13 (buffers/comparators 8 that process information)]. Through its description of program signal unscrambler 24, control and storage unit 26, modulator 28, and demodulator 58, Block discloses at least four such devices.

142. Furthermore, APOSITA would have understood that a programmable processor is a processor capable of being programmed. “The program signal unscrambler 24 operates in response to control signals from the control and storage unit 26 to unscramble the incoming program signal and provide unscrambled audio and video signals UAUD and UVID to a conventional modulator 28” [Block at 3:62-4:9 (emphasis added)]. APOSITA would have understood that, because program signal unscrambler 24 unscrambles the incoming program signal and provides unscrambled audio and video signals in response to control signals from control and storage unit 26, program signal unscrambler 24 is a programmable processor.

143. Block describes that control and storage unit 26 “detects code signals in the incoming scrambled program signal for unscrambling and billing purposes” and generates control signals [Block at 3:62-4:9]. Control and storage unit 26 receives “an accept signal ACC” from control unit 30 that “indicat[es] that the subscriber has assumed the obligation to pay for a particular program to which the equipment is tuned” [Block at 6:44-61]. Because control and storage unit 26 receives an accept signal that controls control and storage unit 26 to accept “a particular carrier frequency” and generate control signals for transmission to program signal unscrambler 24, control and storage unit 26 is a programmable processor [Block at 6:44-61].

144. Block also describes modulator 28 as a device that “modulates a carrier signal of an appropriate carrier frequency with the unscrambled audio and video signals and supplies the unscrambled program signal in the form of a modulated carrier wave to the television set in a conventional manner” [Block at 3:62-4:9 (emphasis added)]. Through its description of modulator 28 modulating a carrier signal of an appropriate carrier frequency, Block teaches a programmable processor that modulates carrier signals based on properties of the received unscrambled audio and video signals [Block at 3:62-4:9].

145. Block describes demodulator 58 as a “conventional demodulator” that recovers the scrambled audio and video signals [Block at 6:44-61 (emphasis

added)). Through its description of demodulator 58 recovering scrambled audio and video signals, Block teaches a programmable processor that detects properties of an incoming scrambled program signal and recovers the scrambled audio and video signals [Block at 6:44-61].

146. Thus, through its description of a subscriber station [“a video receiver”] including program signal unscrambler 24 [“a programmable processor”], control and storage unit 26 [“a programmable processor”], modulator 28 [“a programmable processor”], and demodulator 58 [“a programmable processor”], Block at least renders obvious a video receiver having a plurality of programmable processors.

“receiving a video signal;” (element 102.1)

147. As I have discussed above at ¶¶ 53-55, Block describes the subscriber station that receives “program signals” that include “scrambled audio and video signals as well as various synchronizing signals and codes” [Block at 3:27-37 (emphasis added)]. The program signal “is supplied to the subscriber[station]s either by conventional broadcast or cable techniques” [Block at 3:27-37 (emphasis added)].

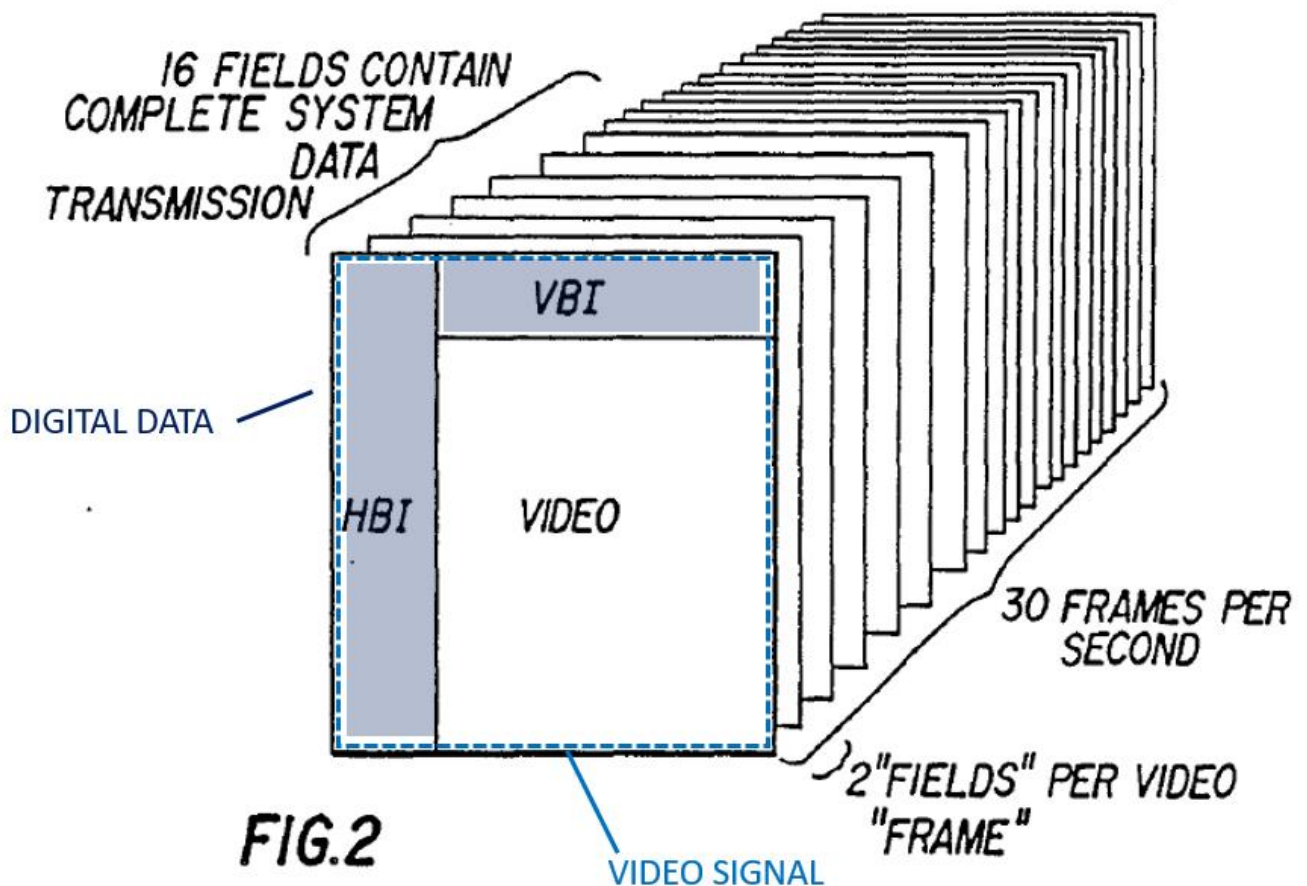
148. Thus, through its description of the subscriber station that receives program signals that include “scrambled audio and video signals,” Block at least renders obvious receiving a video signal [Block at 3:27-37].

“detecting a stream of digital data in said video signal;” (element 102.2)

149. As I have discussed above at ¶¶ 139-148, Block describes receiving scrambled program signals [“said video signal[s]”] that include “scrambled audio and video signals” from the central station equipment 10 [Block at 3:27-37].

150. APOSITA would have found it obvious to interpret features of Block’s system based on the teachings of Seth-Smith. As described above, Seth-Smith teaches a television system for distributing protected program material that includes “a transmitter including a data insertion circuit for inserting a control bit in a transmitted signal comprising other control data and the protected program material” [Seth-Smith at Abstract]. APOSITA would have understood that the scrambled audio and video television signals of Block could be interpreted in view of the teachings of Seth-Smith regarding protected program material, embodied in Seth-Smith as television frames [Seth-Smith at 7:5-45].

151. FIG. 2 of Seth-Smith, which I have annotated, illustrates “the overall transmission format of the system,” and shows a detailed illustration of television frames that “each compris[e] a still image” and include “two ‘fields,’ as also shown” [Seth-Smith at 7:8-22].



SETH-SMITH, FIG. 2 (ANNOTATED)

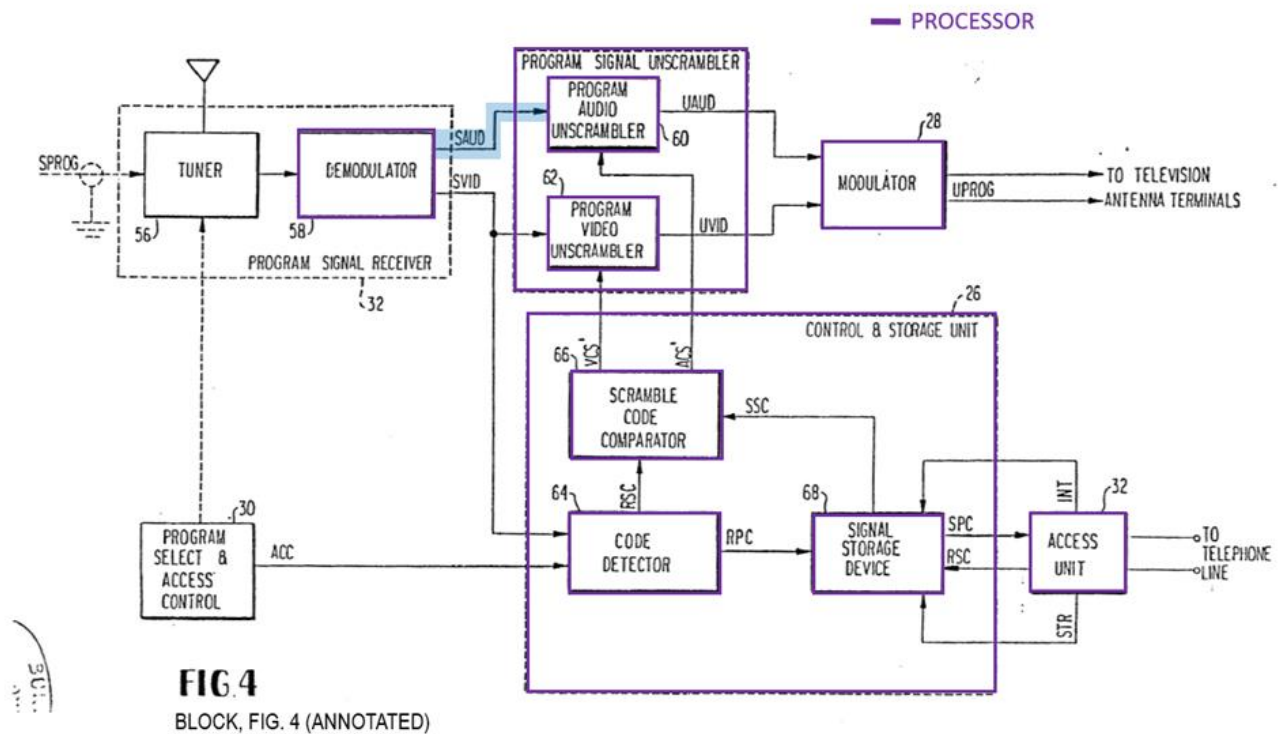
152. The “vertical blanking interval (VBI) of each field contains certain ‘system data’ necessary for operation of a subscription television system according to the invention,” and the “horizontal blanking interval (HBI)” includes “six channels of high quality digitally encoded audio information” [Seth-Smith at 7:8-22 (emphasis)]. The VBI is “377 bits wide. These bits are two level FSK encoded as compared to the four level FSK scheme used in the HBI” [Seth-Smith at 8:40-

51, emphasis added]. FSK, or frequency-shift keying is a modulation approach in which a plurality of discrete frequencies is used to transmit digital information, and was well-known at least at the time of the Critical Date. Thus, APOSITA would have found it obvious to use the detailed description of Seth-Smith's overall transmission format to understand that the scrambled audio and video signals of Block can contain digital data [Seth-Smith at 7:8-8:51]. APOSITA having the teachings of Block in front of them would have a reasonable likelihood of success in extending the digital transmission format teachings of Seth-Smith to the system of Block to render this limitation obvious as Block, and indeed the specification of the '885 Patent itself, teach that underlying components are well-known.

153. Program signal unscrambler 24 unscrambles the scrambled incoming program signal and provides “unscrambled audio and video signals UAUD and UVID to a conventional modulator” [Block at 3:62-4:9]. Through its description of unscrambling the incoming program signal to provide unscrambled audio and video signals, Block renders obvious detecting the scrambled audio and video signals [“stream of digital data”] of the scrambled program signal [“said video signal”]. Thus, Block, in view of Seth-Smith, renders obvious detecting a stream of digital data in a video signal [Block at 3:62-4:9 and Seth-Smith at 7:8-8:51].

“passing a first portion of said stream of digital data among said plurality of programmable processors in a first passing fashion;”
(element 102.3)

154. As I have discussed above at ¶¶ 149-153, APOSITA would have understood, through Seth-Smith’s description of its overall transmission format, that the program signal of Block can be digital data [Seth-Smith at 7:8-8:51]. FIG. 4 of Block, which I have annotated, illustrates a detailed diagram of the subscriber station equipment 12.



155. As I have discussed above at ¶¶ 139-146, program signal unscrambler 24 and control and storage unit 26 are programmable processors [Block at 3:62-

4:9; 6:44-61]. Program audio unscrambler 60 and program video unscrambler 62 of the program signal unscrambler 24 unscramble the scrambled audio and video signals, respectively, of the incoming scrambled program signal [Block at 6:62-7:25]. Accordingly, the program audio unscrambler 60 and the program video unscrambler 62 are processors.

156. Control and storage unit 26 includes code detector 64, scramble code comparator 66, and access unit 32 [Block at 6:44-8:18 and FIG. 4]. Scramble code comparator 66 “receives a stored scramble code signal” and “generates the video and audio unscramble control signals” [Block at 6:44-8:18]. APOSITA would have understood that, because scramble code comparator 66 receives a stored scramble code signal and generates, in response to receiving the stored scramble code signal, video and audio unscramble control signals, scramble code comparator 66 of control and storage unit 26 is a programmable processor [Block at 6:44-8:18].

157. Code detector 64 is “enabled by the accept signal ACC” and “detects the received scramble code” and the “received program code in the video signal” [Block at 6:44-8:18]. APOSITA would have understood that, because code detector 64 is controlled by a receiving accept signal ACC and detects the received scramble code, code detector 64 is a programmable processor [Block at 6:44-8:18].

158. Access unit 32 “later recall[s]” the received program code that has been stored in a “conventional signal storage device 68” [Block at 6:44-8:18]. Additionally, computer 20 may “command the access unit 32 to transmit the stored program code signals SPC from the signal storage device 68 to the computer 20” or “transmit a code to the access unit 32 commanding it to generate a strobe or write signal STR in order to transmit new scramble codes RSC through the access unit to the signal storage device 68” [Block at 7:26-8:18]. APOSITA would have understood that, because access unit 32 is controlled by a code from computer 20, transmits signals, and generates codes, access unit is a programmable processor.

159. As I have discussed above at ¶¶ 139-146, Block at least renders obvious a video receiver having a plurality of programmable processors [Block at 3:62-4:9; 6:44-8:18; 7:26-8:18]. Additionally, through its description of control and storage unit 26, which includes scramble code comparator 66, code detector 64, and access unit 32, Block teaches that control and storage unit 26 is a plurality of programmable processors [Block at 3:62-4:9 and 6:44-8:18].

160. “The scrambled audio signal is supplied to a program audio unscrambler 60 “[a] programmable processor”]” of the program signal unscrambler 24 from demodulator 58 [Block at 6:44-7:25 and FIG. 4]. The scrambled audio signal is a portion of the scrambled audio and video signals [“said stream of digital data”] [Block at 3:27-37]. Thus, through its description of the

scrambled audio signal, Block renders obvious a first portion of said stream of digital data [Block at 3:27-37].

161. As shown in FIG. 4 of Block, the scrambled audio signal is passed in a first passing fashion to the program audio unscrambler 60 of the program signal unscrambler 24 [Block at 3:27-37 and FIG. 4]. Accordingly, Block at least renders obvious passing a first portion of a stream of digital data among a plurality of programmable processors in a first passing fashion.

162. Therefore, through its description of supplying the scrambled audio signal [“a first portion of said stream of digital data”] from demodulator 58 [“[a] programmable processor”] to program audio unscrambler 60 [“[a] programmable processor”], Block teaches a first passing fashion among a plurality of programmable processors [Block at 3:27-37 and FIG. 4].

“passing a control portion of said stream of digital data to a programmable control processor;” (element 102.4)

163. As I have discussed above at ¶¶ 149-153, APOSITA would have understood, by applying Seth-Smith’s description of its overall transmission format to the system of Block, that the program signal of Block is digital data, and that the scrambled audio and video signals are a stream of digital data [Block at 3:62-4:9 and Seth-Smith at 7:8-22].

164. As I have discussed above at ¶¶ 139-146, control and storage unit 26 is a programmable processor [Block at 6:44-61]. “The control and storage unit 26 detects code signals in the incoming scrambled program signal [“said video signal containing said stream of digital data”]” [Block at 11:14-20 (emphasis added)]. The scrambled audio and video signals [“said stream of digital data”] include “transmitted program code TPC” and “stored program code SPC,” which are stored in control and storage unit 26 and are used “for unscrambling and billing purposes” [Block at 4:20-36].

165. Control and storage unit 26 uses the TPC and the SPC to “generate a strobe or write signal STR in order to transmit new scramble codes RSC” to the signal storage device 68 of the control and storage unit 26 [Block at 7:26-8:18]. The control and storage unit 26 compares the RSC to a “stored scramble code SSC” and “generates the video and audio unscramble control signals VCS' and ACS' respectively” [Block at 5:51-7:26]. APOSITA would have understood that, because the code signals detected in the scrambled audio and video signals [“said stream of digital data”] instruct control and storage unit 26 to generate control signals, the code signals are a control portion of the scrambled audio and video signals [“said stream of digital data”] [Block at 5:51-7:26]. Additionally, because control and storage unit 26 generates control signals that control unscrambling of

the scrambled audio and video signals [“said stream of digital data”], control and storage unit 26 is a programmable control processor [Block at 5:51-7:26].

166. Thus, through its description of passing the TPC and the SPC [“a control portion”] to the control and storage unit 26 [“a programmable control processor”], Block at least renders obvious passing a control portion of a stream of digital data to a programmable control processor [Block at 4:20-36, 5:51-7:26, and 7:26-8:18].

“controlling, with said programmable control processor, the passing of a second portion of said stream of digital video data among said plurality of programmable processors in a second passing fashion in response to said passed control portion;” (element 102.5)

167. As I have discussed above at ¶¶ 149-153, APOSITA would have understood, by applying Seth-Smith’s description of its overall transmission format to the system of Block, that the program signal of Block is digital data, and that the scrambled audio and video signals are a stream of digital data [Block at 3:62-4:9 and Seth-Smith at 7:8-22].

168. As I have discussed above at ¶¶ 163-166, control and storage unit 26 is a programmable control processor [Block at 3:62-4:9 and 6:44-8:18]. Control and storage unit 26 “generates the video and audio unscramble control signals VCS' and ACS' respectively” in response to receiving a “stored scramble code

signal SSC from the signal storage device 68” of the control and storage unit 26 [Block at 5:51-7:26].

169. Additionally, Block teaches providing “the scrambled video signal” to both “a program video unscrambler 62 [“[a] programmable processor”] and to a code detector 64 in the control and storage unit 26” [Block at 5:51-7:26]. As shown in FIG. 4 of Block, the scrambled video signal is passed from demodulator 58 [“[a] programmable processor”] to the program video unscrambler 62 [“[a] programmable processor”] of the program signal unscrambler 24 [Block at FIG. 4]. Program video unscrambler 62 [“[a] programmable processor”] is then controlled by control signal VCS' from control and storage unit 26 [“said programmable control processor”] to “invert the subsequent frame of video signals” when RSC is “identified as an invert signal,” or to pass the video signal in “an uninverted form” when RSC is “identified as a non-invert signal” [Block at 6:62-7:25 (emphasis added)]. Program video unscrambler 62 [“[a] programmable processor”] of program signal unscrambler 24 then provides “unscrambled ... video signals ... UVID to a conventional modulator 28 [“[a] programmable processor”]” [Block at 3:62-4:9 (emphasis added)].

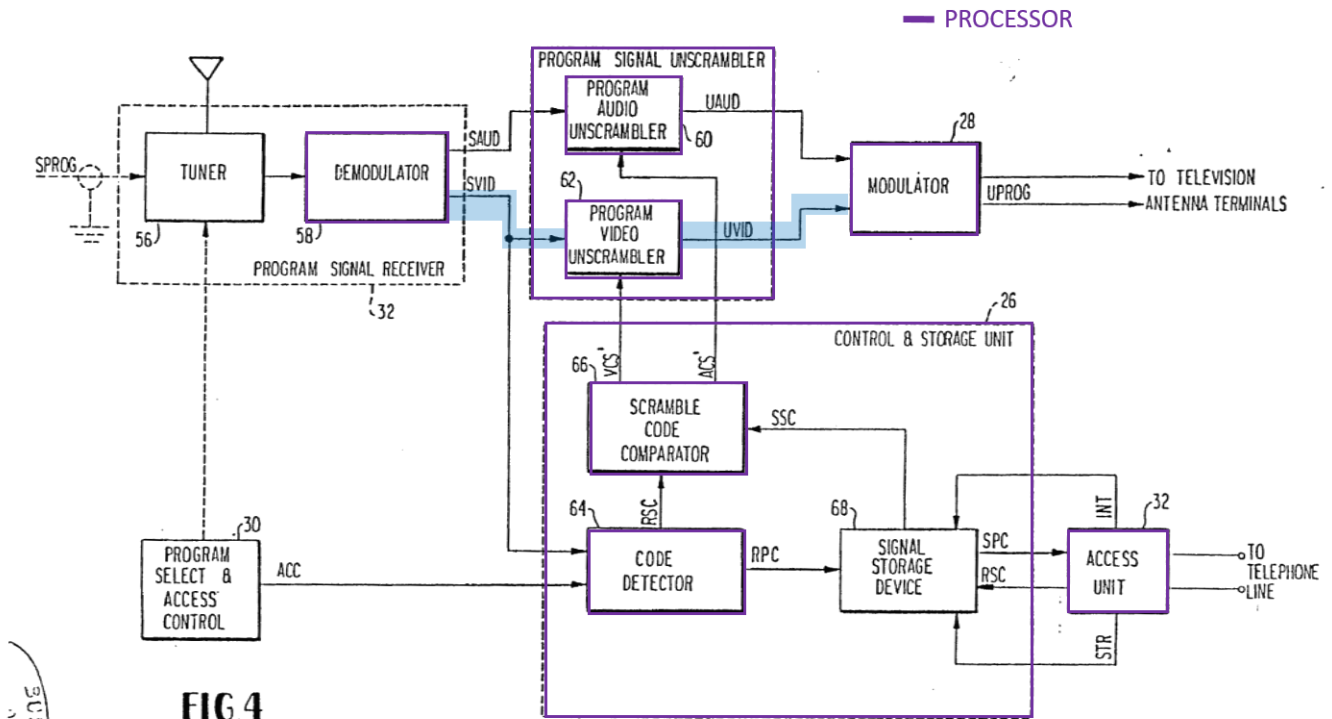


FIG. 4
BLOCK, FIG. 4 (ANNOTATED)

170. The scrambled video signal, and subsequently the unscrambled video signal is a portion of the scrambled audio and video signals [“said stream of digital data”] [Block at 3:27-37]. Thus, through its description of the unscramble video signal, Block renders obvious a second portion of said stream of digital data [Block, 3:27-37].

171. Thus, through its description of the passing of the unscrambled video signal [“a second portion of said stream of digital video data”] from the program video unscrambler 62 [“[a] programmable processor”] to the modulator 28 [“[a] programmable processor”] in response to the VCS', Block teaches passing a second portion of said stream of digital video data in a second passing fashion in response

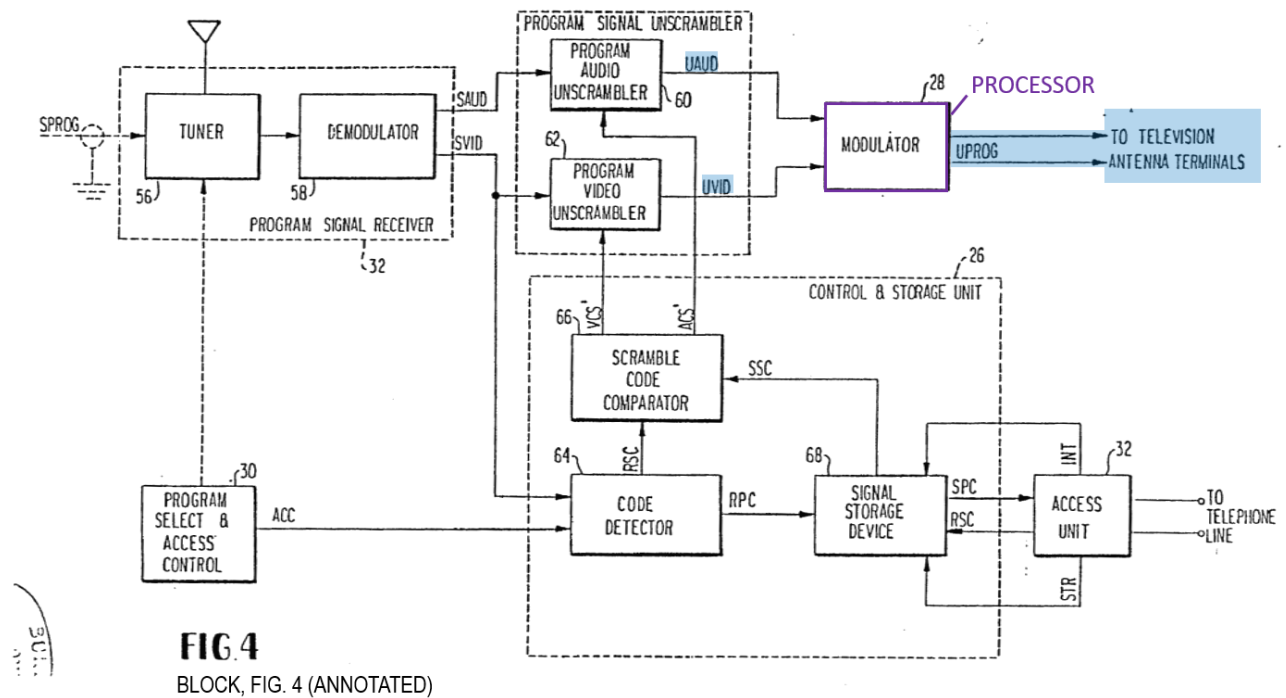
to a control signal from control and storage unit 26 [“said programmable control processor”] [Block at 3:62-4:9, 6:62-7:25, and FIG. 4].

172. Thus, Block at least renders obvious controlling, with a programmable control processor, the passing of a second portion of a stream of digital video data in a second passing fashion in response to a passed control portion [Block at 3:62-4:9, 6:62-7:25, and FIG. 4].

“processing said passed second portion of said stream of digital data and outputting processed information from said plurality of programmable processors to a video display apparatus; and” (element 102.6)

173. “[T]he scrambled program signal SPROG” of Block is sent to a program signal unscrambler 24 [“[a] programmable processor”] and to a control and storage unit 26 [“[a] programmable processor”] [Block at 3:62-4:9]. The program signal unscrambler 24 [“[a] programmable processor”] “provide[s] unscrambled audio and video signals UAUD and UVID to a conventional modulator 28” in response to control signals from control and storage unit 26 [“[a] programmable processor”] [Block at 3:62-4:9]. Modulator 28 “modulates a carrier signal of an appropriate carrier frequency with the unscrambled audio and video signals [“said passed second portion of said stream of digital data”] and supplies

the unscrambled program signal in the form of a modulated carrier wave to the television set in a conventional manner” [Block at 3:62-4:9 (emphasis added)].



174. Thus, through its description of modulating the unscrambled video signal UVID [“said passed second portion of said stream of digital data”], Block teaches processing said passed second portion of said stream of digital data [Block at 3:62-4:9].

175. APOSITA would understand that a television set is a video display apparatus. Thus, through its description of modulating unscrambled audio and video signals [“said passed second portion of said stream of digital data”] and providing the modulated carrier wave [“processed information”] to a television set [“a video display apparatus”], Block at least renders obvious processing a second

portion of a stream of digital data and outputting processed information from a programmable processor to a video display apparatus [Block, 3:62-4:9].

“displaying video at said video display apparatus based on said outputted processed information from said plurality of programmable processors.” (element 102.7)

176. As I have discussed above at ¶¶ 173-175, Block describes providing a modulated carrier wave [“outputted processed information”] of unscrambled audio and video signals to a television set [“said video display apparatus”] [Block at 3:62-4:9]. The modulated carrier wave of the unscrambled program signal UPROG is provided to “the television set in a conventional manner” [Block at 3:62-4:9].

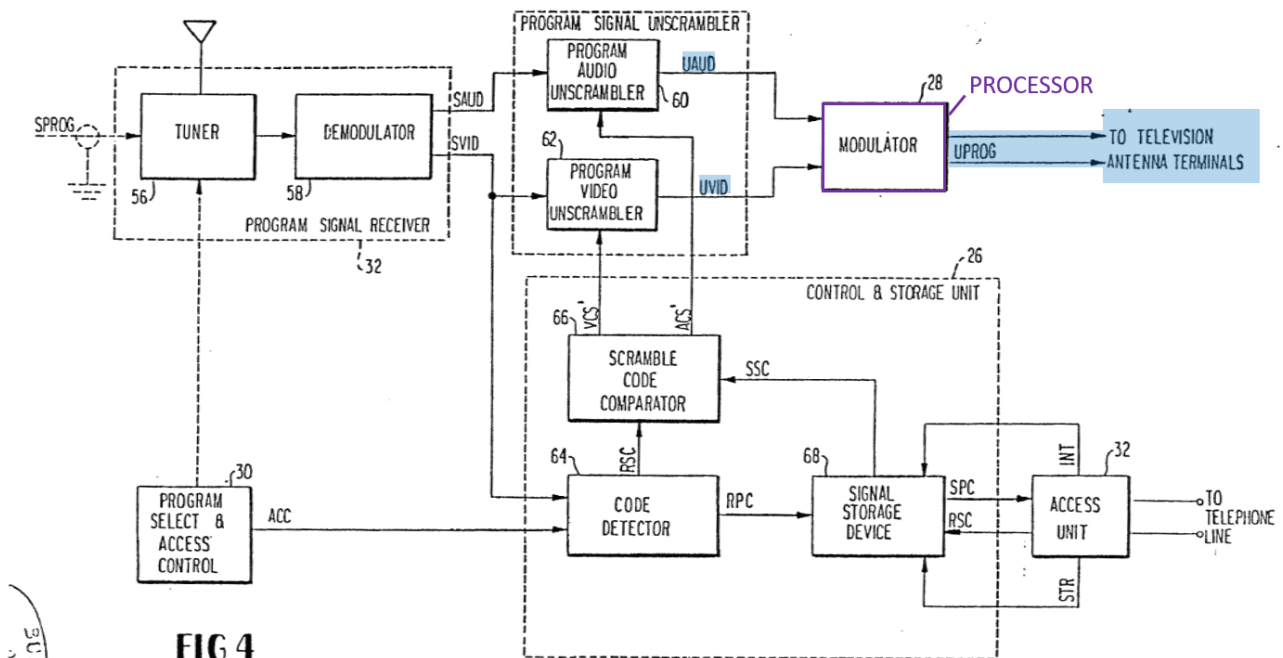


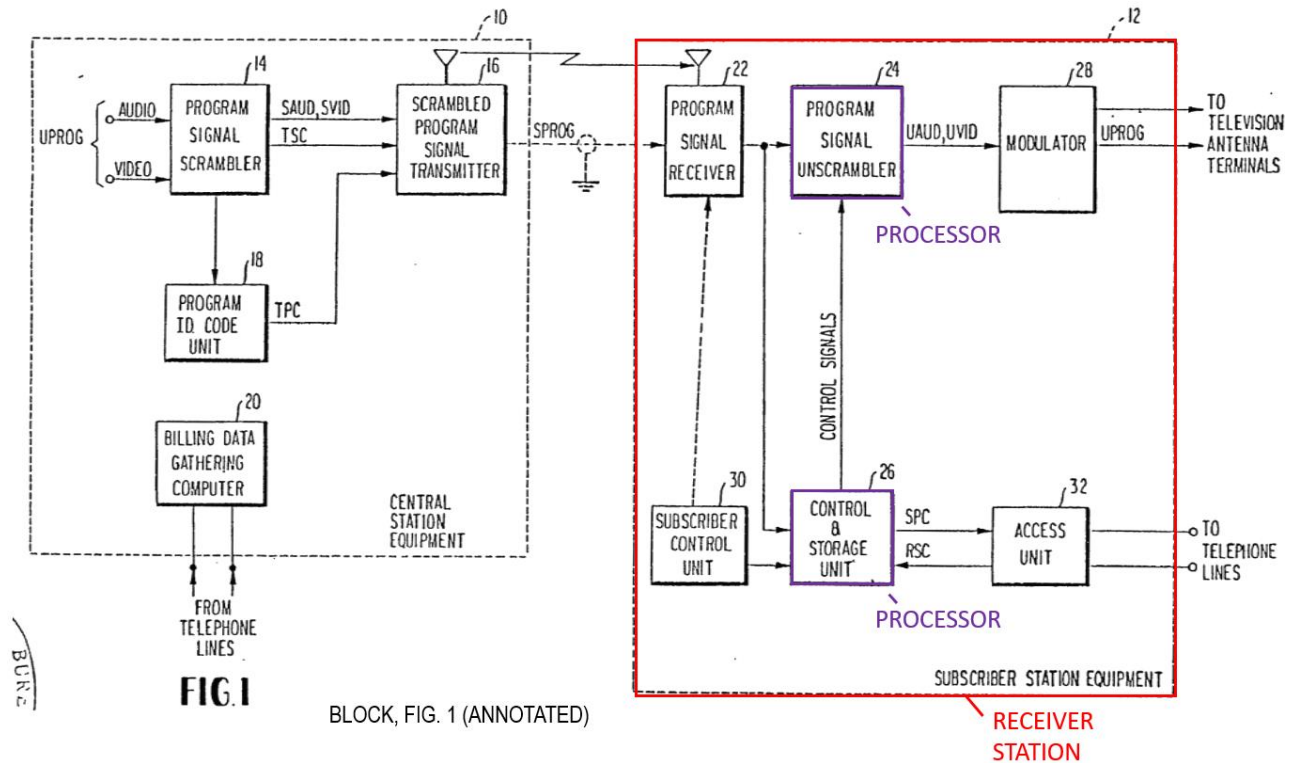
FIG. 4
BLOCK, FIG. 4 (ANNOTATED)

177. Block also describes that the television system of Block “enables the display” of programs [Block at claim 10]. Additionally, APOSITA would have understood that providing audio and video signals to a television set would cause the television set to display the provided audio and video.

178. Thus, Block at least renders obvious displaying video at a video display apparatus based on processed information from programmable processors [Block at 3:62-4:9, claim 10].

**“A method of processing signals at a receiver station, said receiver station having a plurality of programmable processors for processing a stream of digital data messages, said method comprising the steps of:”
(element 105.0)**

179. Block describes a subscriber station that receives “program signals” that include “scrambled audio and video signals as well as various synchronizing signals and codes” [Block at 3:27-37]. APOSITA would have understood that, because Block’s subscriber station receives program signals including “scrambled audio and video signals,” the subscriber station is a receiver station. FIG. 1 of Block, which I have annotated, illustrates subscriber station equipment, labeled with reference number 12 within the subscriber station taught by Block.



180. Program signals are transmitted to the subscriber station equipment 12 from “the central station equipment 10,” and “the received signal is supplied both to a program signal unscrambler 24 and to a control and storage unit 26” [Block at 3:62-4:9].

181. As I have discussed above at ¶¶ 39-43, a “processor” should be construed broadly enough to include “a device or module that operates on analog or digital signals” [’885 Patent at 135:52-56 (decoders 30 and 40 that process information), 76:11-13 (buffers/comparators 8 that process information)]. Through its description of program signal unscrambler 24, control and storage unit 26, modulator 28, and demodulator 58, Block discloses four such devices.

182. APOSITA would have understood that a programmable processor is a processor capable of being programmed. “The program signal unscrambler 24 operates in response to control signals from the control and storage unit 26 to unscramble the incoming program signal and provide unscrambled audio and video signals UAUD and UVID to a conventional modulator 28” [Block at 3:62-4:9 (emphasis added)]. Because program signal unscrambler 24 unscrambles the incoming program signal and provides unscrambled audio and video signals in response to control signals from control and storage unit 26, program signal unscrambler 24 is a programmable processor [Block at 3:62-4:9].

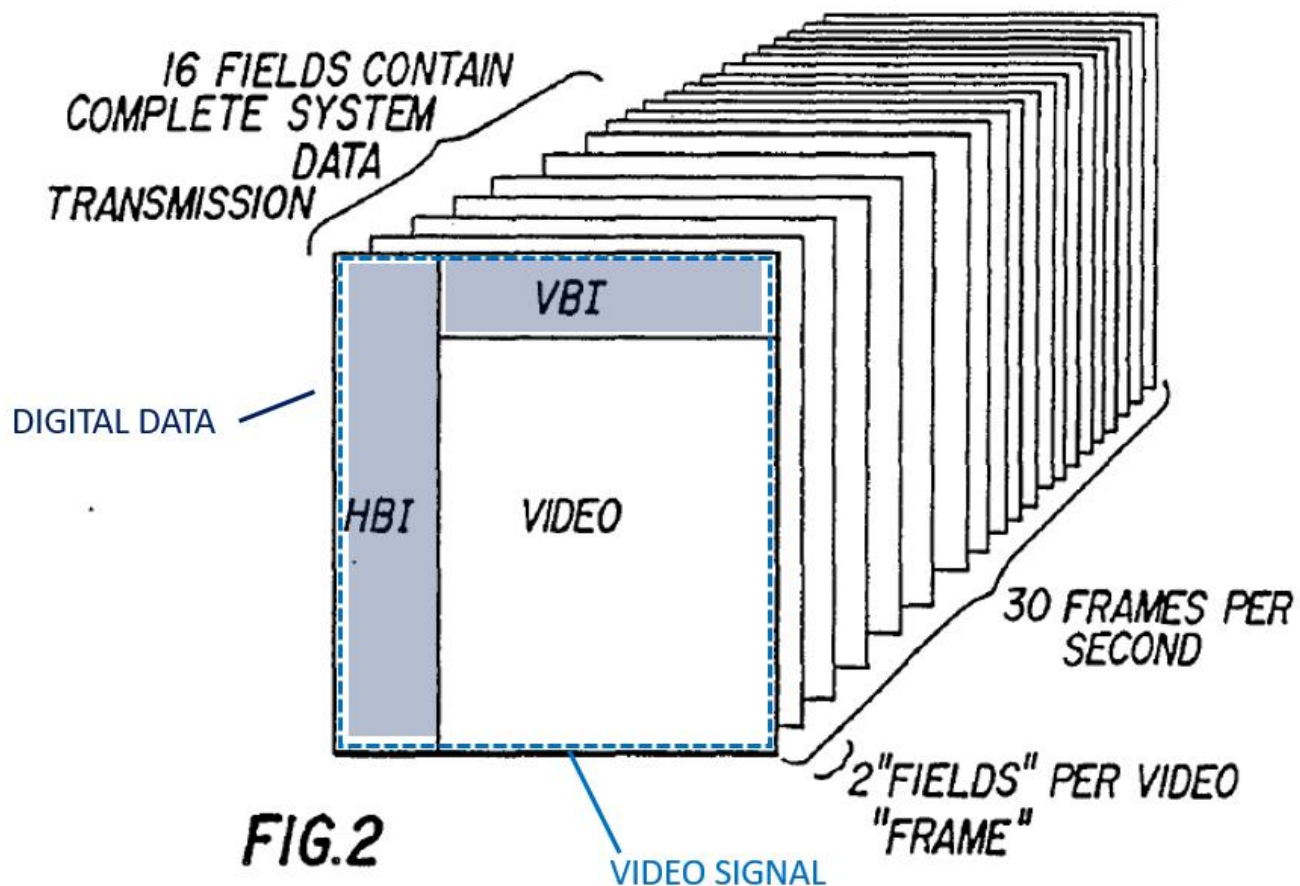
183. Block describes that control and storage unit 26 “detects code signals in the incoming scrambled program signal for unscrambling and billing purposes” and generates control signals [Block at 3:62-4:9]. Control and storage unit 26 receives “an accept signal ACC” from control unit 30 that “indicat[es] that the subscriber has assumed the obligation to pay for a particular program to which the equipment is tuned” [Block at 6:44-61]. APOSITA would have understood that, because control and storage unit 26 receives an accept signal that controls control and storage unit 26 to accept “a particular carrier frequency” and generate control signals for transmission to program signal unscrambler 24, control and storage unit 26 is a programmable processor.

184. Block also describes modulator 28 as a device that “modulates a carrier signal of an appropriate carrier frequency with the unscrambled audio and video signals and supplies the unscrambled program signal in the form of a modulated carrier wave to the television set in a conventional manner” [Block at 3:62-4:9 (emphasis added)]. Through its description of modulator 28 modulating a carrier signal of an appropriate carrier frequency, Block teaches a programmable processor that modulates carrier signals based on properties of the received unscrambled audio and video signals.

185. Block describes demodulator 58 as a “conventional demodulator” that recovers the scrambled audio and video signals [Block at 6:44-61 (emphasis added)]. Through its description of demodulator 58 recovering scrambled audio and video signals, Block teaches a programmable processor that detects properties of an incoming scrambled program signal and recovers the scrambled audio and video signals.

186. Thus, through its description of a subscriber station [“a receiver station”] including program signal unscrambler 24 [“a programmable processor”], control and storage unit 26 [“a programmable processor”], modulator 28 [“a programmable processor”], and demodulator 58 [“a programmable processor”], Block at least renders obvious a receiver station having a plurality of programmable processors.

187. APOSITA would have found it obvious to interpret features of Block's system based on the teachings of Seth-Smith. As described above, Seth-Smith teaches a television system for distributing protected program material that includes "a transmitter including a data insertion circuit for inserting a control bit in a transmitted signal comprising other control data and the protected program material" [Seth-Smith at Abstract]. APOSITA would have understood that the scrambled audio and video television signals of Block could be interpreted in view of the teachings of Seth-Smith regarding protected program material, embodied in Seth-Smith as television frames [Seth-Smith at 7:5-45]. Accordingly, APOSITA would have understood that the program signals of Block are digital messages based on the teachings of Seth-Smith. FIG. 2 of Seth-Smith, which I have annotated, illustrates "the overall transmission format of the system," and shows a detailed illustration of television frames that "each compris[e] a still image" and include "two 'fields,' as also shown" [Seth-Smith at 7:8-22].



SETH-SMITH, FIG. 2 (ANNOTATED)

188. The “vertical blanking interval (VBI) of each field contains certain ‘system data’ necessary for operation of a subscription television system according to the invention,” and the “horizontal blanking interval (HBI)” includes “six channels of high quality digitally encoded audio information” [Seth-Smith at 7:8-22 (emphasis added)]. The VBI is “377 bits wide. These bits are two level FSK encoded as compared to the four level FSK scheme used in the HBI” [Seth-Smith

at 8:40-51 (emphasis added)]. FSK, or frequency-shift keying is a modulation approach in which a plurality of discrete frequencies is used to transmit digital information, and was well-known at least at the time of the Critical Date. Thus, APOSITA would have found it obvious to use the detailed description of Seth-Smith's overall transmission format to understand that the scrambled audio and video signals of Block can contain digital data [Seth-Smith at 7:8-8:51].

APOSITA having the teachings of Block in front of them would have a reasonable likelihood of success in extending the digital transmission format teachings of Seth-Smith to the system of Block to render this limitation obvious as Block, and indeed the specification of the '885 Patent itself, teach that underlying components are well-known.

189. Program signal unscrambler 24 unscrambles the scrambled incoming program signal and provides “unscrambled audio and video signals UAUD and UVID to a conventional modulator” [Block at 3:62-4:9]. Through its description of unscrambling the incoming program signal to provide unscrambled audio and video signals, Block renders obvious processing and detecting the scrambled audio and video signals [“stream of digital data messages”] of the scrambled program signal [Block at 3:62-4:9]. Thus, Block, in view of Seth-Smith, renders obvious a stream of digital data messages [Block at 3:62-4:9 and Seth-Smith at 7:8-22].

190. Accordingly, Block at least renders obvious a receiver station having a plurality of programmable processors for processing a stream of digital data messages.

“receiving a broadcast or cablecast transmission;” (element 105.1)

191. As I have discussed above at ¶¶ 139-146, Block describes the subscriber station that receives “program signals [“a cablecast transmission”]” that include “scrambled audio and video signals as well as various synchronizing signals and codes” [Block at 3:27-37]. The program signal “is supplied to the subscriber[station]s either by conventional broadcast or cable techniques” [Block at 3:27-37 (emphasis added)]. Through its description of receiving a program signal via cable techniques at the subscriber station, Block at least renders obvious receiving a cablecast transmission.

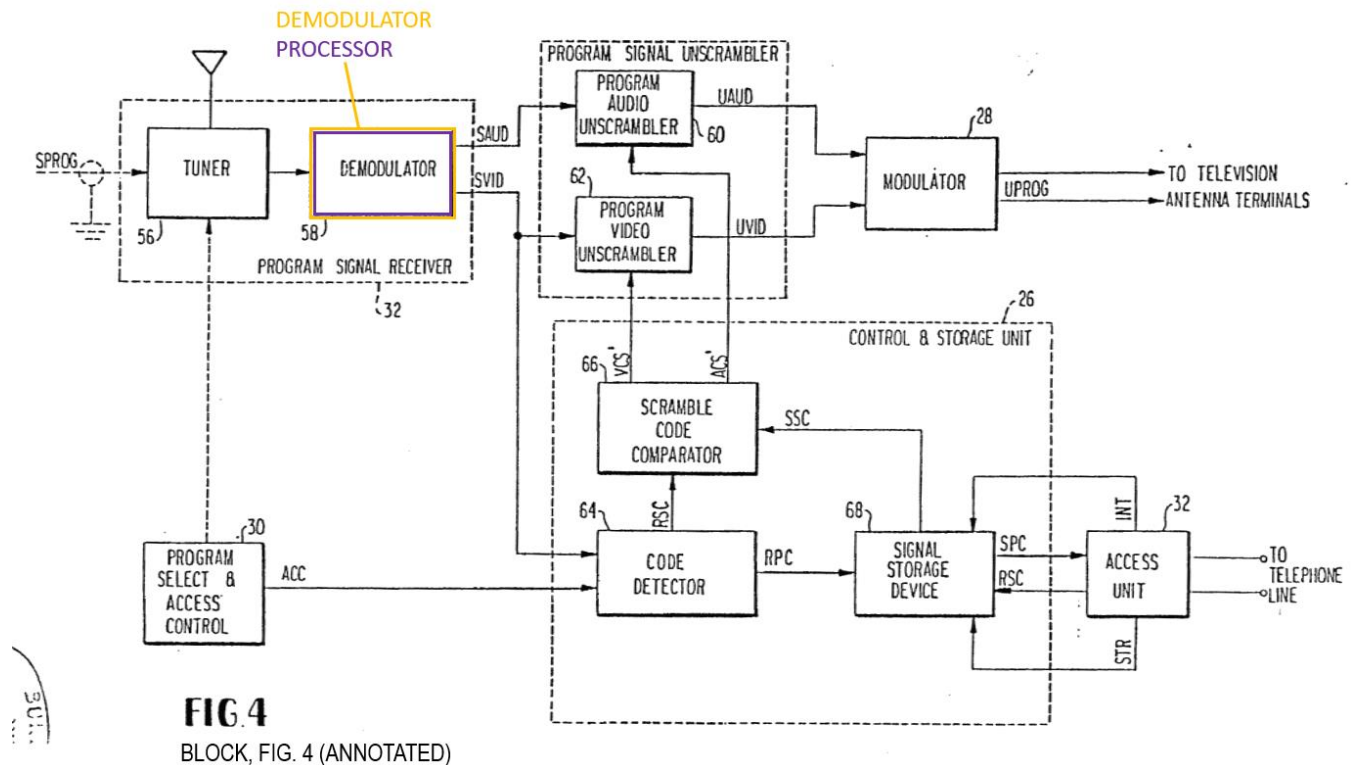
“demodulating said broadcast or cablecast transmission to detect an information transmission thereon, said information transmission including said stream of digital data messages;” (element 105.2)

192. Block describes receiving the transmitted program signal at a “program signal receiver 22” that “selects a particular carrier frequency through the use of a conventional tuner and demodulates the incoming program signal [“said cablecast transmission”] to recover the audio, video and code signals” [Block at 5:8-32 (emphasis added)]. APOSITA would have understood that,

because the audio, video, and code signals recovered from the incoming program signal [“said cablecast transmission”] are information, the audio, video, and code signals are an information transmission [Block at 5:8-32]. Thus, through its description of demodulating the incoming program signal to recover the audio, video, and code signals, Block teaches demodulating a cablecast transmission to detect an information transmission [Block at 5:8-32].

193. As I have discussed above at ¶¶ 179-190, the scrambled audio and video signals [“an information transmission”] are a stream of digital data messages [Block at 3:62-4:9 and Seth-Smith at 7:8-22].

194. As shown in FIG. 4, Block describes demodulator 58 of program signal receiver 22, which is “a conventional demodulator” “for recovery of the scrambled audio and scrambled video signals” [Block at 6:44-61].

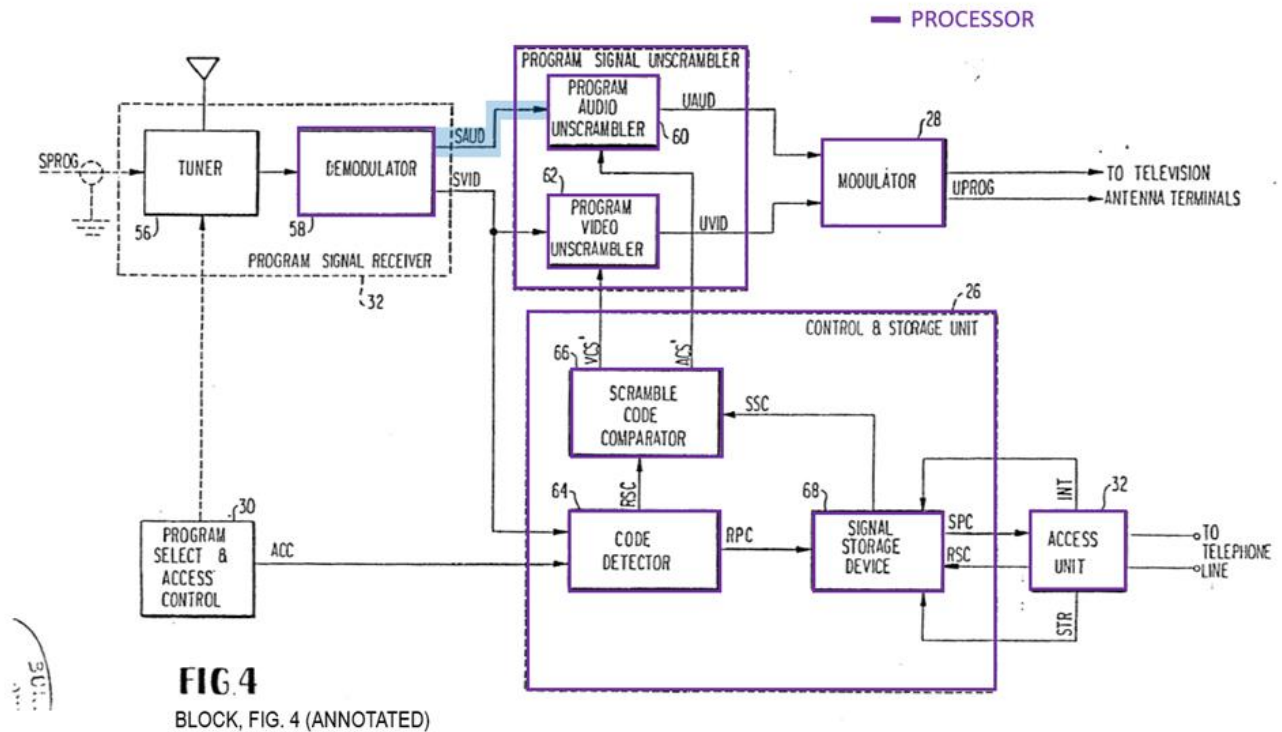


195. Thus, through its description of demodulator 58 that demodulates the incoming program signal [“said cablecast transmission”] to recover the audio, video and code signals [“said information transmission”] that are digital data [“said stream of digital messages”], Block at least renders obvious demodulating a cablecast transmission to detect an information transmission that includes a stream of digital data messages [Block at 5:8-32 and 6:44-61].

“detecting a first digital data message of said stream of digital data messages on said information transmission;” (element 105.3)

196. As I have discussed above at ¶¶ 179-195, APOSITA would have understood, through Seth-Smith’s description of its overall transmission format,

that the program signal of Block includes scrambled audio and video signals [“said information transmission”] [Seth-Smith at 7:8-22]. FIG. 4 of Block, which I have annotated illustrates a detailed diagram of the subscriber station equipment 12.



197. Demodulator 58 recovers “the scrambled audio and scrambled video signals,” and provides the “scrambled audio signal ... to a program audio unscrambler 60” of the program signal unscrambler 24 [Block at 6:44-7:25 and FIG. 4]. The scrambled audio signal is a message of the stream of scrambled audio and video signals [“said stream of digital data messages”] [Block at 3:27-37]. Thus, through its description of the demodulator recovering the scrambled audio

signal, Block renders obvious detecting a first digital data message of said stream of digital data [Block at 3:27-37 and FIG. 4].

“passing said first digital data message among said plurality of programmable processors; and” (element 105.4)

198. As I have discussed above at ¶¶ 196-197, demodulator 58 recovers “the scrambled audio and scrambled video signals,” and provides the “scrambled audio signal [“said first digital data message”] ... to a program audio unscrambler 60” of the program signal unscrambler 24 [Block at 6:44-7:25 and FIG. 4]. FIG. 4 of Block, which I have annotated, illustrates the path of the scrambled audio signal.

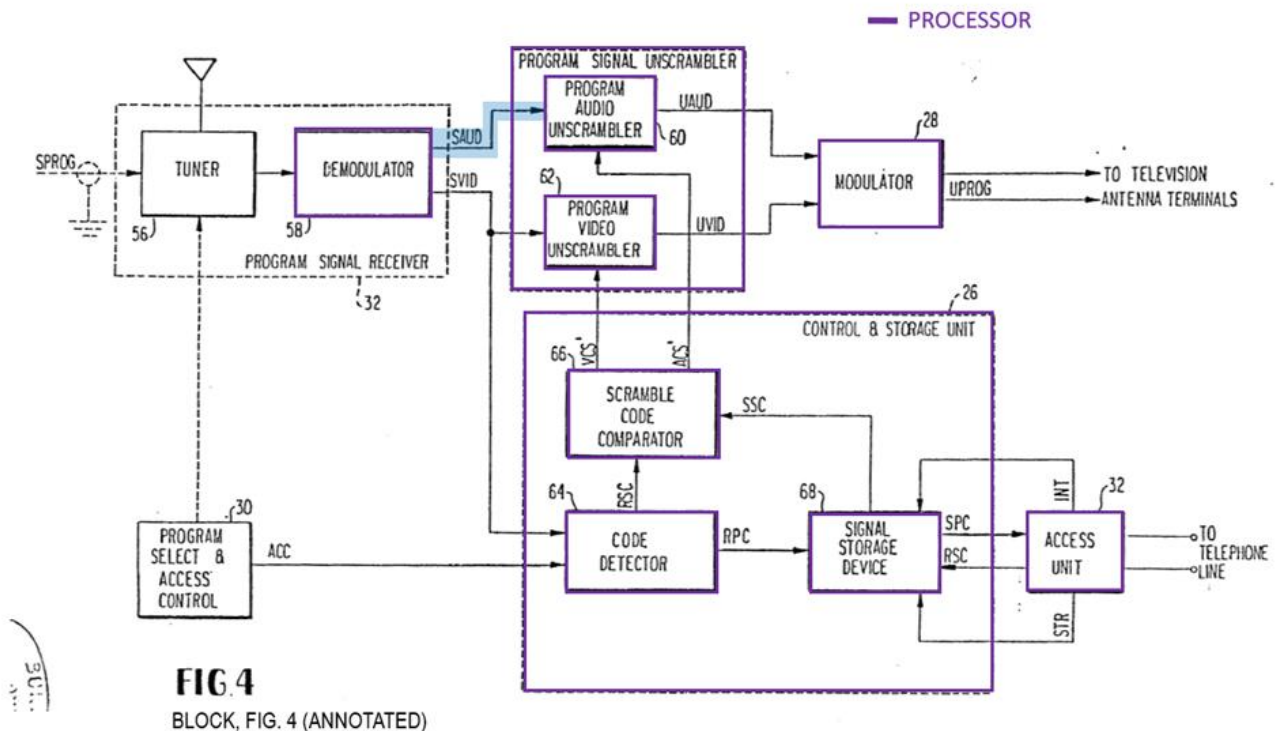


FIG. 4
BLOCK, FIG. 4 (ANNOTATED)

199. As I have discussed above at ¶¶ 179-190, Block renders obvious a receiver station having a plurality of programmable processors [Block at 3:62-4:9 and 6:44-8:18]. Additionally, through its description of control and storage unit 26, which includes scramble code comparator 66, code detector 64, and access unit 32, Block teaches that control and storage unit 26 is a plurality of programmable processors [Block at 3:62-4:9 and 6:44-8:18].

200. “The scrambled audio signal [“said first digital data message”] is supplied to a program audio unscrambler 60 [“[a] programmable processor”]” of the program signal unscrambler 24 from demodulator 58 [“[a] programmable processor”] [Block at 6:44-7:25 and FIG. 4]. Thus, through its description of the scrambled audio signal, Block renders obvious a first portion of said stream of digital data [Block at 3:27-37].

201. Therefore, through its description of supplying the scrambled audio signal [“said first digital data message”] from demodulator 58 [“[a] programmable processor”] to program audio unscrambler 60 [“[a] programmable processor”], Block at least renders obvious passing said first digital data message among a plurality of programmable processors [Block at 3:27-37 and FIG. 4].

“causing, using a programmable control processor, at least one of said plurality of programmable processors to receive only some of said first digital data message, thereby to cause said plurality of programmable

processors to process said first digital data message selectively, where the only some of the data message processed by said plurality of programmable processors contains a control signal;” (element 105.5)

202. As I have discussed above at ¶¶ 179-190, control and storage unit 26 is a programmable processor [Block at 6:44-61]. “The control and storage unit 26 detects code signals in the incoming scrambled program signal [“said video signal containing said stream of digital data”]” [Block at 6:44-61 (emphasis added)]. The scrambled audio and video signals [“said stream of digital data”] include “transmitted program code TPC” and “stored program code SPC,” which are stored in control and storage unit 26 and are used “for unscrambling and billing purposes” [Block at 4:20-36].

203. Control and storage unit 26 uses the TPC and the SPC to “generate a strobe or write signal STR in order to transmit new scramble codes RSC” to the signal storage device 68 of the control and storage unit 26 [Block at 7:26-8:18]. The control and storage unit 26 compares the RSC to a “stored scramble code SSC” and “generates the video and audio unscramble control signals VCS' and ACS' respectively” [Block at 5:51-7:26]. APOSITA would have understood that code signals that cause control and storage unit 26 to generate control signals are control signals [Block at 5:51-7:26]. APOSITA would have understood that, because control and storage unit 26 generates control signals that control

unscrambling of the scrambled audio and video signals [“said stream of digital data”], control and storage unit 26 is a programmable control processor [Block at 5:51-7:26].

204. “The control and storage unit 26 also detects the transmitted program code TPC in the incoming program signal and stores the program code of a particular program being viewed” [“cause said plurality of programmable processors to process said first digital data message selectively”]” [Block at 4:20-36 (emphasis added)].

205. APOSITA would have understood that storing the program code of a particular program in control and storage unit 26 would cause control and storage unit 26 to receive only the program code of the particular program to be stored, and therefore only some of a digital data message containing multiple program codes.

206. Through its description of detecting code signals in the incoming scrambled program signal and storing the program code of a particular program being viewed, Block renders obvious causing a processor to receive only some of a first digital data message, thereby causing the processor to process the first digital data message selectively, where the only some of the data message processed contains a control signal [Block at 4:20-36].

207. Additionally, APOSITA would have found it obvious to use the decoding hardware of Seth-Smith to “perform this function” of the system of

Block to display information “on a subscriber’s television screen” [Seth-Smith at 15:39-46]. A B-MAC signal is input to the decoding hardware of Seth-Smith, and data [“a first portion”] “contained in the vertical blanking interval” [“said stream of digital data”] are passed to a “Microprocessor and Teletext Support” or MATS that assists a microprocessor [Seth-Smith at 16:6-20; 18:19-39]. The MATS examines “addressed packets and supplies” the addressed packets to the microprocessor “for generation of control signals [“a first control signal”] and decryption keys” [Seth-Smith at 18:19-39]. APOSITA having the teachings of Block in front of them would have a reasonable likelihood of success in extending the digital transmission format teachings of Seth-Smith to the system of Block to render this limitation obvious as Block, and indeed the specification of the ’885 Patent itself, teach that underlying components are well-known.

208. “Meanwhile, the remaining portions [“a second portion”] of the vertical blanking interval data” are processed by the MATS. *Id.* The teletext data is stored in RAM and is subsequently supplied to a character generator after decryption using the encryption keys provided by the microprocessor [“in a second passing fashion”] [Seth-Smith at 18:19-39].

209. Through its description of processing the addressed packets and supplying the addressed packets [“only some of a first digital data message”] to the microprocessor to generate control signals and decryption keys and leaving the

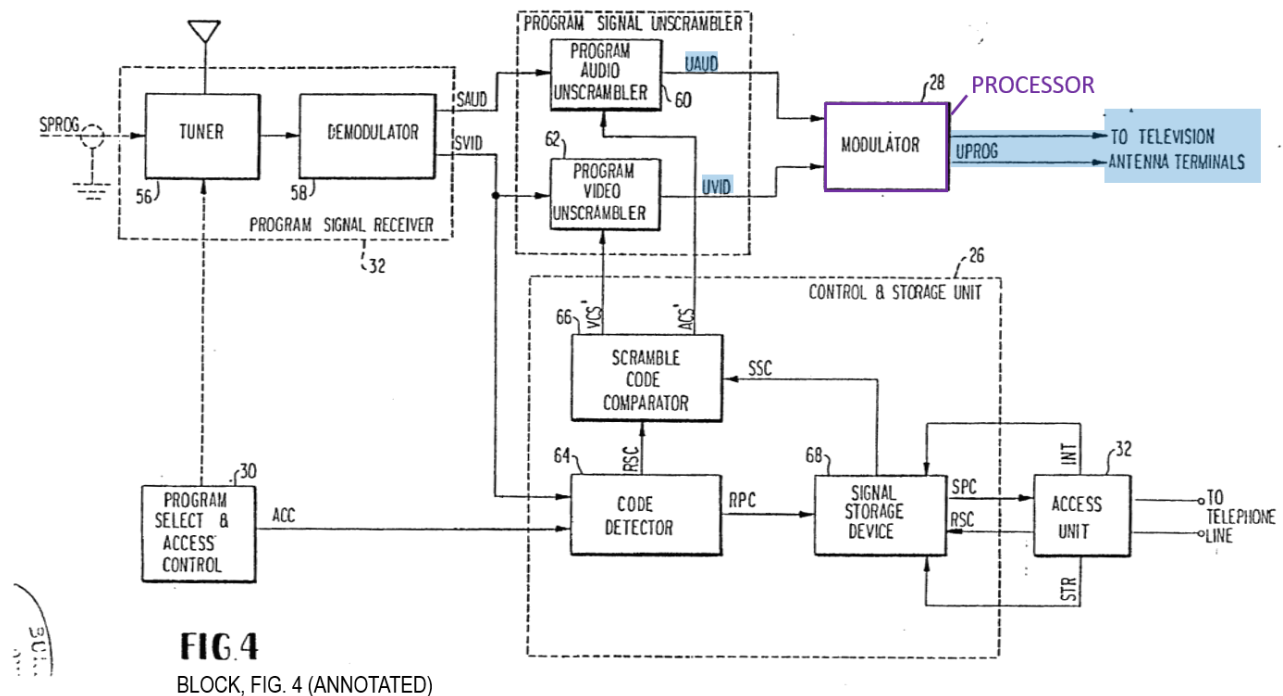
“remaining portions” to be processed by the MATS, Seth-Smith renders obvious causing a processor to receive only some of a first digital data message, thereby causing the processor to process the first digital data message selectively, where the only some of the data message processed contains a control signal.

210. Accordingly, Block and Seth-Smith render obvious causing a programmable control processor to receive only some of a first digital data message, thereby causing the processor to process the first digital data message selectively, where the only some of the data message processed contains a control signal.

“outputting image information from said plurality of programmable processors to an image display device based on said causing.” (element 105.6)

211. “[T]he scrambled program signal SPROG” of Block is sent to a program signal unscrambler 24 “[a] programmable processor”] and to a control and storage unit 26 “[a] programmable processor”] [Block at 3:62-4:9]. The program signal unscrambler 24 “[a] programmable processor”] “provide[s] unscrambled audio and video signals UAUD and UVID to a conventional modulator 28” in response to control signals from control and storage unit 26 “[a] programmable processor”] [Block at 3:62-4:9]. Modulator 28 “modulates a carrier signal of an appropriate carrier frequency with the unscrambled audio and video

signals and supplies the unscrambled program signal in the form of a modulated carrier wave to the television set in a conventional manner” [Block at 3:62-4:9 (emphasis added)].



212. Because the unscrambled video signal UVID contains video information, which includes image information, Block describes processing a signal and outputting image information through its description of modulating the unscrambled video signal UVID and providing the modulated carrier wave to a television set.

213. APOSITA would understand that a television set is an image display apparatus. Thus, through its description of using modulator 28 “[a] programmable processor”) to modulate unscrambled audio and video signals and provide the

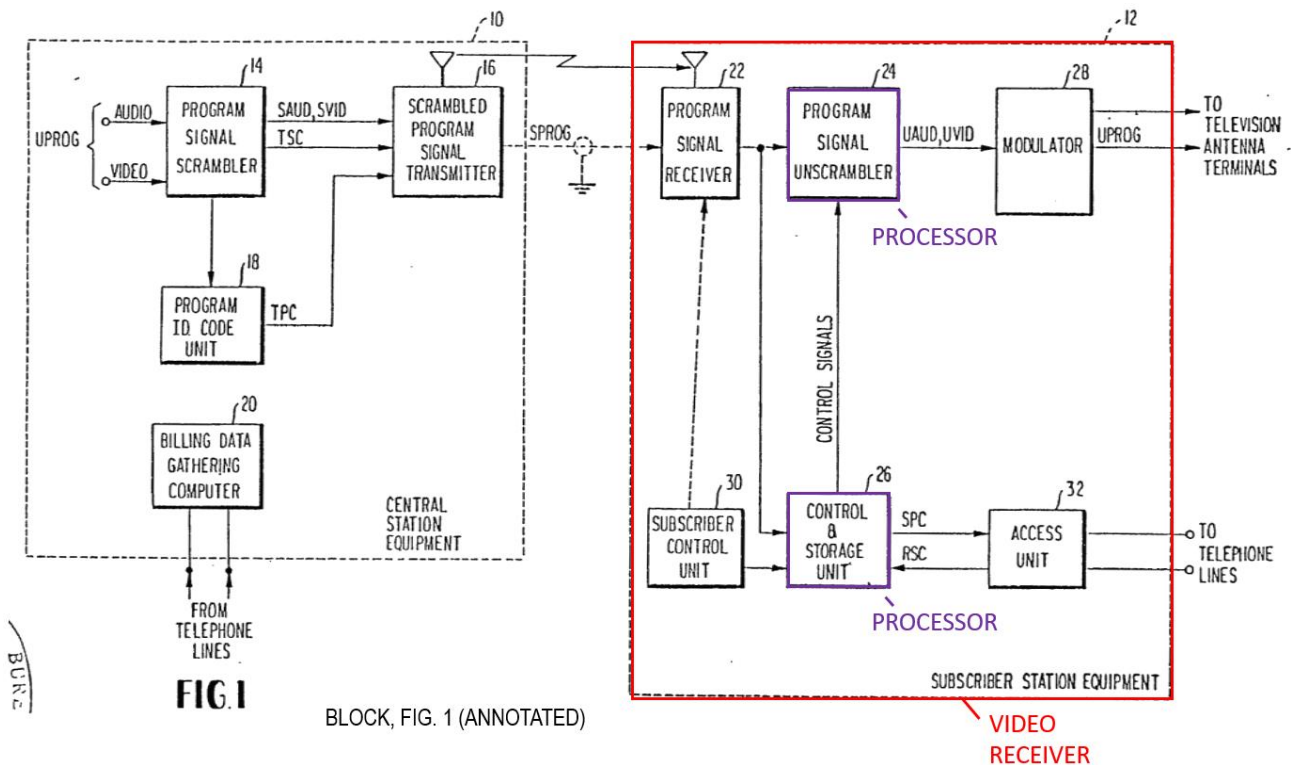
modulated carrier wave [“image information”] to a television set [“an image display apparatus”], Block renders obvious outputting image information from a programmable processor to an image display apparatus [Block at 3:62-4:9].

214. As I have discussed above at ¶¶ 202-210, control and storage unit 26 “stores the program code of a particular program being viewed” [“cause said plurality of programmable processors to process said first digital data message selectively”] [Block at 4:20-36 (emphasis added)]. The stored program code is used “for unscrambling and billing purposes,” and causes program signal unscrambler 24 [“[a] programmable processor”] “provide[s] unscrambled audio and video signals UAUD and UVID to a conventional modulator 28” [Block at 4:20-36]. APOSITA would have understood that, because the unscrambled audio and video signals are provided to modulator 28 in response to receiving the stored program code of a particular program being viewed [“only some of said first digital message”], Block’s system, in view of the teachings of Seth-Smith, at least renders obvious outputting image information from said plurality of programmable processors to an image display device based on causing said plurality of programmable processors to process said first digital data message selectively.

“A method of processing signals in a receiver of a broadcast or cablecast transmission, said receiver including a controllable device and having a

plurality of programmable processors, said method comprising the steps of:” (element 106.0)

215. Block describes a subscriber station that receives “program signals” that include “scrambled audio and video signals as well as various synchronizing signals and codes” [Block at 3:27-37]. APOSITA would have understood that, because Block’s subscriber station receives program signals including “scrambled audio and video signals,” the subscriber station is a receiver [Block at 3:27-37 (emphasis added)]. FIG. 1 of Block illustrates subscriber station equipment, labeled with reference number 12, within the subscriber station taught by Block.



216. Program signals are transmitted to the subscriber station equipment 12 from “the central station equipment 10,” and “the received signal is supplied both to a program signal unscrambler 24 and to a control and storage unit 26” [Block at 3:62-4:9].

217. As I have discussed above at ¶¶ 39-43, a “processor” should be construed broadly enough to include “a device or module that operates on analog or digital signals” [’885 Patent at 135:52-56 (decoders 30 and 40 that process information), 76:11-13 (buffers/comparators 8 that process information)]. Through its description of program signal unscrambler 24, control and storage unit 26, modulator 28, and demodulator 58, Block renders obvious four such devices.

218. APOSITA would have understood that a programmable processor is a processor capable of being programmed. “The program signal unscrambler 24 operates in response to control signals from the control and storage unit 26 to unscramble the incoming program signal and provide unscrambled audio and video signals UAUD and UVID to a conventional modulator 28” [Block at 3:62-4:9 (emphasis added)]. APOSITA would have understood that, because program signal unscrambler 24 unscrambles the incoming program signal and provides unscrambled audio and video signals in response to control signals from control and storage unit 26, program signal unscrambler 24 is a programmable processor [Block at 3:62-4:9].

219. Block describes that control and storage unit 26 “detects code signals in the incoming scrambled program signal for unscrambling and billing purposes” and generates control signals [Block at 3:62-4:9]. Control and storage unit 26 receives “an accept signal ACC” from control unit 30 that “indicat[es] that the subscriber has assumed the obligation to pay for a particular program to which the equipment is tuned” [Block at 6:44-61]. APOSITA would have understood that, because control and storage unit 26 receives an accept signal that controls control and storage unit 26 to accept “a particular carrier frequency” and generate control signals for transmission to program signal unscrambler 24, control and storage unit 26 is a programmable processor.

220. Block also describes modulator 28 as a device that “modulates a carrier signal of an appropriate carrier frequency with the unscrambled audio and video signals and supplies the unscrambled program signal in the form of a modulated carrier wave to the television set in a conventional manner” [Block at 3:62-4:9 (emphasis added)]. Through its description of modulator 28 modulating a carrier signal of an appropriate carrier frequency, Block teaches a programmable processor that modulates carrier signals based on properties of the received unscrambled audio and video signals [Block at 3:62-4:9].

221. Block describes demodulator 58 as a “conventional demodulator” that recovers the scrambled audio and video signals [Block at 6:44-61 (emphasis

added)). Through its description of demodulator 58 recovering scrambled audio and video signals, Block teaches a programmable processor that detects properties of an incoming scrambled program signal and recovers the scrambled audio and video signals [Block at 6:44-61].

222. Thus, through its description of a subscriber station [“a video receiver”] including program signal unscrambler 24 [“a programmable processor”], control and storage unit 26 [“a programmable processor”], modulator 28 [“a programmable processor”], and demodulator 58 [“a programmable processor”], Block renders obvious a video receiver having a plurality of programmable processors.

223. Additionally, APOSITA would have understood that the programmable processors and components in the receiver are each a controllable device. Accordingly, Block at least renders obvious a receiver including a controllable device.

“receiving a broadcast or cablecast signal;” (element 106.1)

224. As I have discussed above at ¶¶ 215-223, Block describes the subscriber station that receives “program signals” that include “scrambled audio and video signals as well as various synchronizing signals and codes” [Block at 3:27-37]. The program signal “is supplied to the subscriber[station]s either by conventional broadcast or cable techniques” [Block at 3:27-37 (emphasis added)].

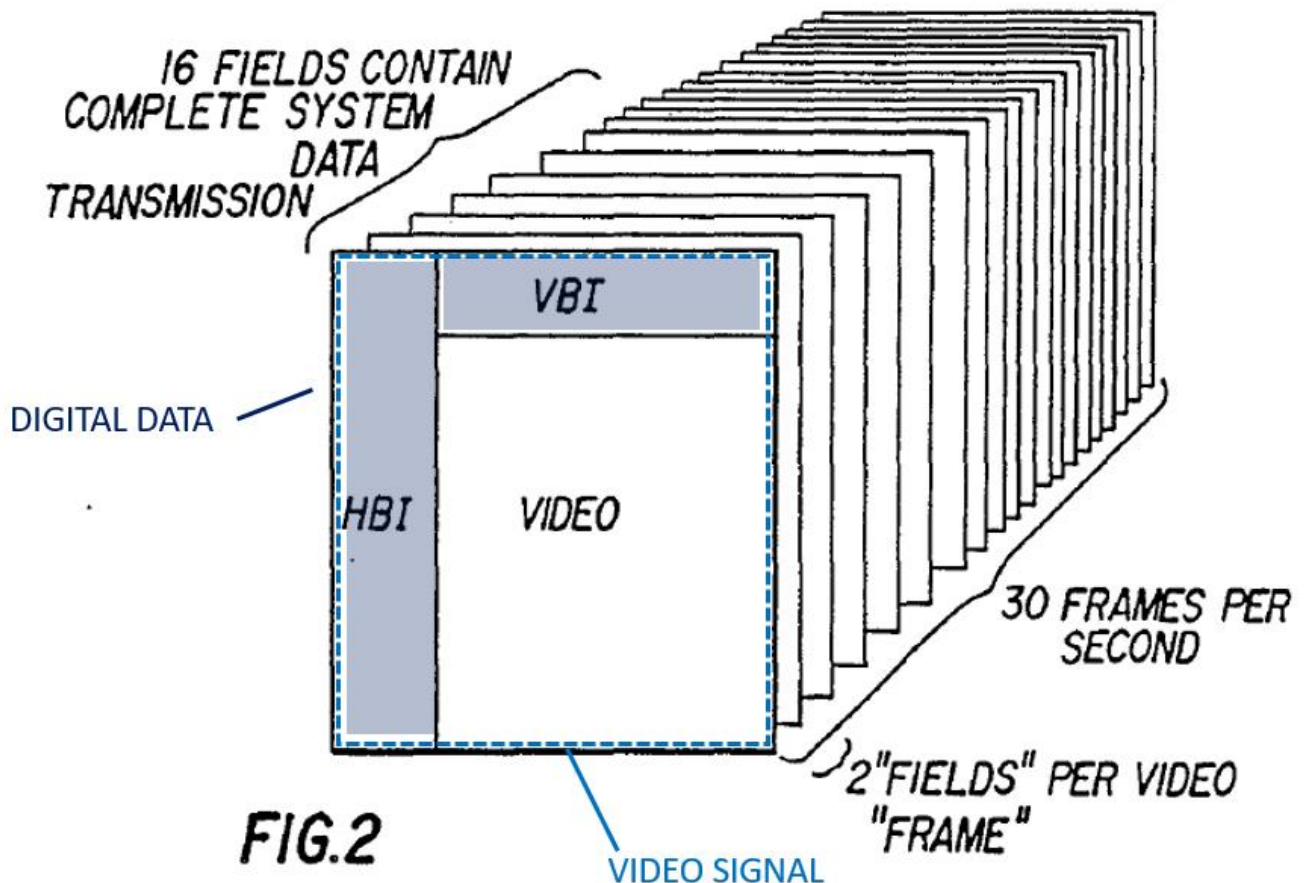
225. Thus, Block at least renders obvious receiving a broadcast or cablecast signal.

“detecting a stream of digital data on said received signal;” (element 106.2)

226. As I have discussed above at ¶¶ 149-153, Block describes receiving scrambled program signals [“said received signal[s]”] that include “scrambled audio and video signals” from the central station equipment 10 [Block at 3:27-37].

227. APOSITA would have found it obvious to interpret features of Block’s system based on the teachings of Seth-Smith. As described above, Seth-Smith teaches a television system for distributing protected program material that includes “a transmitter including a data insertion circuit for inserting a control bit in a transmitted signal comprising other control data and the protected program material” [Seth-Smith at Abstract]. APOSITA would have understood that the scrambled audio and video television signals of Block could be interpreted in view of the teachings of Seth-Smith regarding protected program material, embodied in Seth-Smith as television frames [Seth-Smith at 7:5-45]. Accordingly, APOSITA would have understood that the program signals of Block are digital based on the teachings of Seth-Smith. FIG. 2 of Seth-Smith, reproduced below, illustrates “the overall transmission format of the system,” and shows a detailed illustration of

television frames that “each compris[e] a still image” and include “two ‘fields,’ as also shown” [Seth-Smith at 7:8-22].



SETH-SMITH, FIG. 2 (ANNOTATED)

228. The “vertical blanking interval (VBI) of each field contains certain ‘system data’ necessary for operation of a subscription television system according to the invention,” and the “horizontal blanking interval (HBI)” includes “six channels of high quality digitally encoded audio information” [Seth-Smith at 7:8-

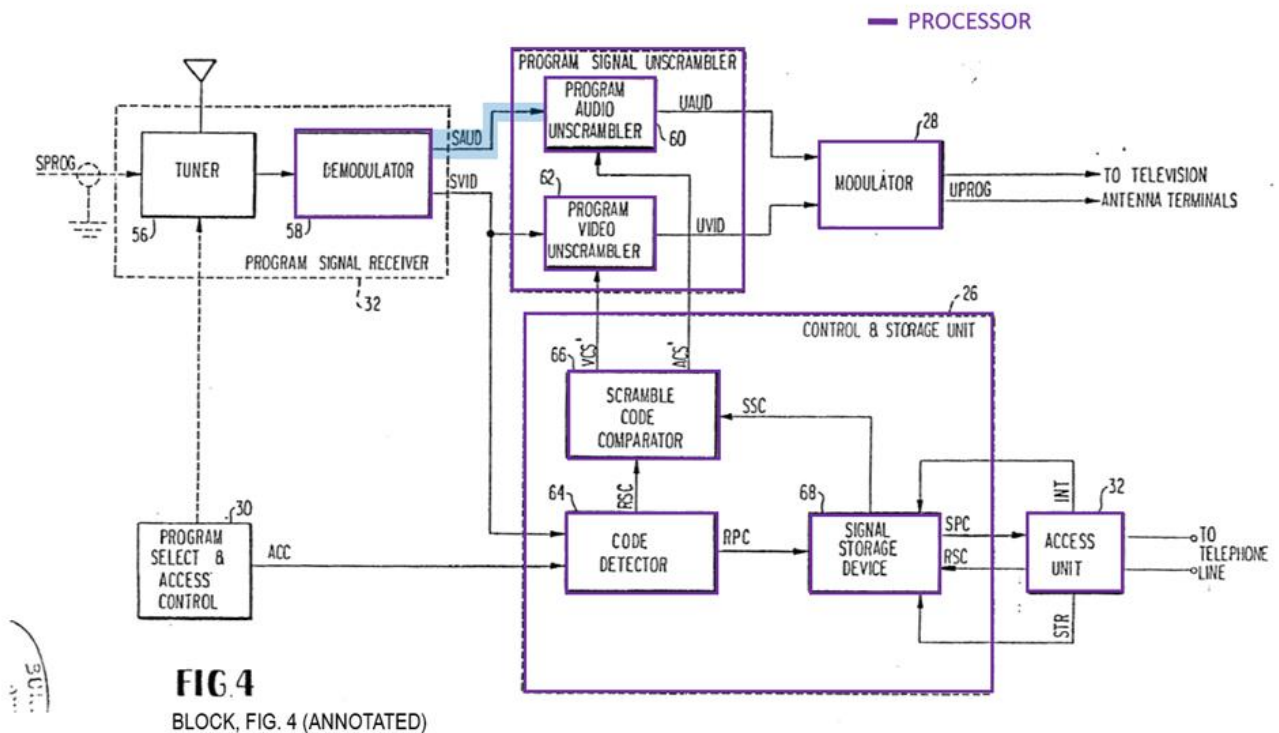
22 (emphasis added)]. The VBI is “377 bits wide. These bits are two level FSK encoded as compared to the four level FSK scheme used in the HBI” [Seth-Smith at 8:40-51, emphasis added]. FSK, or frequency-shift keying is a modulation approach in which a plurality of discrete frequencies is used to transmit digital information, and was well-known at least at the time of the Critical Date. Thus, APOSITA would have found it obvious to use the detailed description of Seth-Smith’s overall transmission format to understand that the scrambled audio and video signals of Block can contain digital data [Seth-Smith at 7:8-8:51]. APOSITA having the teachings of Block in front of them would have a reasonable likelihood of success in extending the digital transmission format teachings of Seth-Smith to the system of Block to render this limitation obvious as Block, and indeed the specification of the ’885 Patent itself, teach that underlying components are well-known.

229. Program signal unscrambler 24 unscrambles the scrambled incoming program signal and provides “unscrambled audio and video signals UAUD and UVID to a conventional modulator” [Block at 3:62-4:9]. Through its description of unscrambling the incoming program signal to provide unscrambled audio and video signals, Block renders obvious detecting the scrambled audio and video signals [“stream of digital data”] of the scrambled program signal [“said received signal”] [Block at 3:62-4:9]. Thus, Block, in view of Seth-Smith, renders obvious

detecting a stream of digital data in a received signal [Block at 3:62-4:9 and Seth-Smith at 7:8-22].

“passing a first portion of said stream of digital data among said plurality of programmable processors in a first passing fashion;”
(element 106.3)

230. As I have discussed above at ¶¶ 154-162, APOSITA would have understood, through Seth-Smith’s description of its overall transmission format, that the program signal of Block is digital data [Seth-Smith at 7:8-22]. FIG. 4 of Block, which I have annotated, illustrates a detailed diagram of the subscriber station equipment 12.



231. As I have discussed above at ¶¶ 215-223, program signal unscrambler 24 and control and storage unit 26 are programmable processors [Block at 3:62-4:9, 6:44-61]. Program audio unscrambler 60 and program video unscrambler 62 of the program signal unscrambler 24 unscramble the scrambled audio and video signals, respectively, of the incoming scrambled program signal [Block at 6:62-7:25]. Accordingly, the program audio unscrambler 60 and the program video unscrambler 62 are processors.

232. Control and storage unit 26 includes code detector 64, scramble code comparator 66, and access unit 32 [Block at 6:44-8:18 and FIG. 4]. Scramble code comparator 66 “receives a stored scramble code signal” and “generates the video and audio unscramble control signals” [Block at 6:44-8:18]. APOSITA would have understood that, because scramble code comparator 66 receives a stored scramble code signal and generates, in response to receiving the stored scramble code signal, video and audio unscramble control signals, scramble code comparator 66 of control and storage unit 26 is a programmable processor [Block at 6:44-8:18].

233. Code detector 64 is “enabled by the accept signal ACC” and “detects the received scramble code” and the “received program code in the video signal” [Block at 6:44-8:18]. APOSITA would have understood that, because code

detector 64 is controlled by a receiving accept signal ACC and detects the received scramble code, code detector 64 is a programmable processor [Block at 6:44-8:18].

234. Access unit 32 “later recall[s]” the received program code that has been stored in a “conventional signal storage device 68” [Block at 6:44-8:18]. Additionally, computer 20 may “command the access unit 32 to transmit the stored program code signals SPC from the signal storage device 68 to the computer 20” or “transmit a code to the access unit 32 commanding it to generate a strobe or write signal STR in order to transmit new scramble codes RSC through the access unit to the signal storage device 68” [Block at 7:26-8:18]. Because access unit 32 is controlled by a code from computer 20, transmits signals, and generates codes, access unit is a programmable processor [Block at 7:26-8:18].

235. As I have discussed above at ¶¶ 215-223, Block renders obvious a receiver of a broadcast or cablecast transmission having a plurality of programmable processors [Block at 3:62-4:9 and 6:44-8:18]. Additionally, through its description of control and storage unit 26, which includes scramble code comparator 66, code detector 64, and access unit 32, Block teaches that control and storage unit 26 is a plurality of programmable processors [Block at 3:62-4:9 and 6:44-8:18].

236. “The scrambled audio signal is supplied to a program audio unscrambler 60 [“[a] programmable processor”]” of the program signal

unscrambler 24 from demodulator [Block at 6:44-7:25 and FIG. 4]. The scrambled audio signal is a portion of the scrambled audio and video signals [“said stream of digital data”] [Block at 3:27-37]. Thus, through its description of the scrambled audio signal, Block renders obvious a first portion of said stream of digital data [Block at 3:27-37].

237. As shown in FIG. 4 of Block, the scrambled audio signal is passed in a first passing fashion to the program audio unscrambler 60 of the program signal unscrambler 24 [Block at 3:27-37 and FIG. 4]. Accordingly, Block renders obvious passing a first portion of a stream of digital data among a plurality of programmable processors [Block at 3:27-37].

238. Therefore, through its description of supplying the scrambled audio signal [“a first portion of said stream of digital data”] from demodulator 58 [“[a] programmable processor”] to program audio unscrambler 60 [“[a] programmable processor”], Block, in view of Seth-Smith, at least renders obvious passing a first portion of a stream of digital data in a first passing fashion among a plurality of programmable processors [Block at 3:27-37 and FIG. 4 and Seth-Smith at 7:8-22].

“processing said passed first portion of said stream of digital data into a first control signal;” (element 106.4)

239. As I have discussed above at ¶¶ 226-229, APOSITA would have understood, by applying Seth-Smith’s description of its overall transmission format

to the system of Block, that the program signal of Block is digital data, and that the scrambled audio and video signals are a stream of digital data [Block at 3:62-4:9 and Seth-Smith at 7:8-22].

240. As I have discussed above at ¶¶ 215-223, control and storage unit 26 is a programmable processor [Block at 6:44-61]. “The control and storage unit 26 detects code signals in the incoming scrambled program signal [“said video signal containing said stream of digital data”]” [Block at 6:44-61 (emphasis added)]. The scrambled audio and video signals [“said stream of digital data”] include “transmitted program code TPC” and “stored program code SPC,” which are stored in control and storage unit 26 and are used “for unscrambling and billing purposes” [Block at 4:20-36].

241. Control and storage unit 26 uses the TPC and the SPC to “generate a strobe or write signal STR in order to transmit new scramble codes RSC” to the signal storage device 68 of the control and storage unit 26 [Block at 7:26-8:18]. The control and storage unit 26 compares the RSC to a “stored scramble code SSC” and “generates the video and audio unscramble control signals VCS' and ACS' respectively” [Block at 5:51-7:26]. APOSITA would have understood that, because the code signals detected in the scrambled audio and video signals [“said stream of digital data”] instruct control and storage unit 26 to generate control signals, the code signals are a control portion of the scrambled audio and video

signals [“said stream of digital data”] [Block at 5:51-7:26]. Additionally, because control and storage unit 26 generates control signals that control unscrambling of the scrambled audio and video signals [“said stream of digital data”], control and storage unit 26 is a programmable control processor [Block at 5:51-7:26].

242. The control and storage unit 26 uses the TPC and the SPC to “generate a strobe or write signal STR in order to transmit new scramble codes RSC” to the signal storage device 68 of the control and storage unit 26 [Block at 7:26-8:18]. The control and storage unit 26 compares the RSC to a “stored scramble code SSC” and “generates the video and audio unscramble control signals VCS' [“first control signal”] and ACS' respectively” [Block at 5:51-7:26 (emphasis added)].

243. Additionally, APOSITA would have found it obvious to use the decoding hardware of Seth-Smith to “perform this function” of the system of Block to display information “on a subscriber’s television screen” [Seth-Smith at 15:39-46]. A B-MAC signal is input to the decoding hardware of Seth-Smith, and data [“a first portion”] “contained in the vertical blanking interval” [“said stream of digital data”] is passed to a “Microprocessor and Teletext Support” or MATS that assists a microprocessor [Seth-Smith at 16:6-20 and 18:19-39]. The MATS examines “addressed packets and supplies” the addressed packets to the microprocessor “for generation of control signals [“a first control signal”] and

decryption keys” [Seth-Smith at 18:19-39]. APOSITA having the teachings of Block in front of them would have a reasonable likelihood of success in extending the digital transmission format teachings of Seth-Smith to the system of Block to render this limitation obvious as Block, and indeed the specification of the ’885 Patent itself, teach that underlying components are well-known.

244. Through its description of processing the addressed packets to generate control signals and decryption keys, which can be used as control signals to decrypt data, Seth-Smith describes processing a first portion of a stream of digital data into a first control signal [Seth-Smith at 18:19-39].

245. Thus, Block and Seth-Smith render obvious processing a first portion of a stream of digital data into a first control signal.

“passing a control portion of said stream of digital data to a programmable control processor;” (element 106.5)

246. As I have discussed above at ¶¶ 215-247, the control and storage unit 26 “generates the video and audio unscramble control signals VCS' and ACS' respectively” [Block at 5:51-7:26]. The unscramble control signals are “supplied to the respective program video unscrambler 62 and the program audio unscrambler 60 in order to reconstitute the scrambled video and audio signals” [Block at 6:62-7:25].

247. As I have discussed above at ¶¶ 215-223, the program video unscrambler 62 and the program audio unscrambler 60 are processors. Thus, through its description of passing unscramble control signals [“a control portion”] from control and storage unit 26 [“[a] programmable processor”] to program video unscrambler 62 [“[a] programmable processor”] or program audio unscrambler 20 [“[a] programmable processor”], Block renders obvious passing a control portion of a stream of digital data to a programmable control processor.

“controlling the passing of said first control signal from said plurality of programmable processors to said controllable device in response to said passed control portion; and” (element 106.6)

248. As I have discussed above at ¶¶ 246-247, Block describes that unscramble control signals VCS' [“first control signal”] and ACS' are transmitted to the program video unscrambler 62 and the program audio unscrambler 60 respectively. The program signal unscrambler 24 [“controllable device”] “operates in response to control signals from the control and storage unit 26 to unscramble the incoming program signal” [Block at 6:62-7:25].

249. As I have discussed above at ¶¶ 215-223, APOSITA would have understood that components of the subscriber station are controllable devices. Thus, through its discussion of passing the generated control signals VCS' [“first control signal”] and ACS' to the program signal unscrambler 24 [“controllable

device”] in response to the control and storage unit 26 receiving the SCC [“said passed control portion”], Block at least renders obvious controlling the passing of a first control signal from a processor to a controllable device in response to the passed control portion [Block at 6:62-7:25].

“controlling said controllable device in response to said first control signal, including:” (element 106.7)

250. As I have discussed above at ¶¶ 248-249, the program signal unscrambler 24 [“controllable device”] “operates in response to control signals [“said first control signal”] from the control and storage unit 26 to unscramble the incoming program signal” [Block at 6:62-7:25]. Thus, through its description of controlling the program signal unscrambler 24 based on unscramble control signals from the control and storage unit 26, Block at least renders obvious controlling the controllable device in response to a first control signal [Block at 6:62-7:25].

**“controlling the passing of a second portion of said stream of digital data among said plurality of programmable processors in a second passing fashion in response to said passed control portion; and”
(element 106.8)**

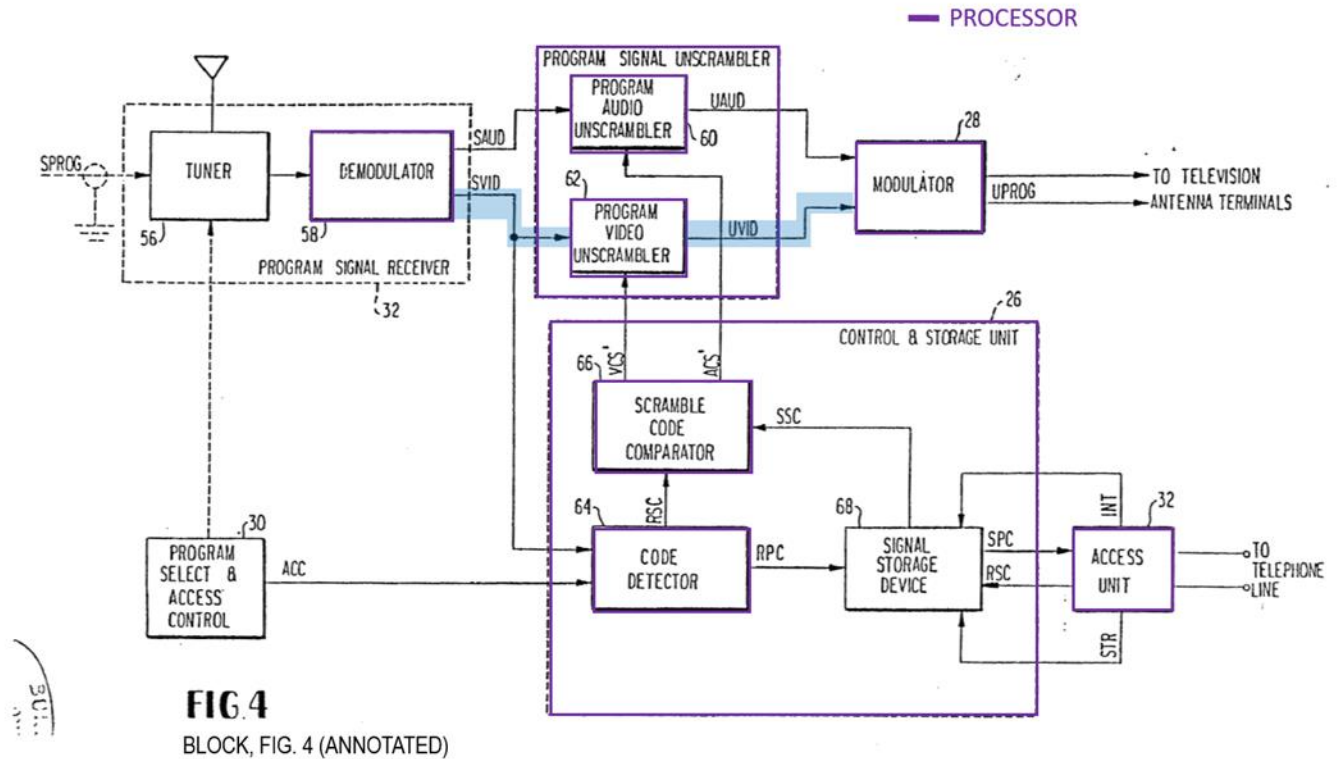
251. As I have discussed above at ¶¶ 167-172, APOSITA would have understood, through Seth-Smith’s description of its overall transmission format, that the program signal of Block is digital data [Block at 3:62-4:9 and Seth-Smith

at 7:8-22]. Block teaches providing “the scrambled video signal” to both “a program video unscrambler 62 and to a code detector 64 in the control and storage unit 26” [Block at 5:51-7:26].

252. As I have discussed above at ¶¶ 215-247, the control and storage unit 26 [“said plurality of programmable control processors”] “generates the video and audio unscramble control signals VCS' and ACS' respectively” in response to receiving a “stored scramble code signal SSC from the signal storage device 68” of the control and storage unit 26 [Block at 5:51-7:26]. The control signal VCS' causes the program video unscrambler 62 of the program signal unscrambler 24 to “invert the subsequent frame of video signals” when RSC is “identified as an invert signal,” or passing the video signal in “an uninverted form” when RSC is “identified as a non-invert signal” [Block at 6:62-7:25].

253. As shown in FIG. 4 of Block, the scrambled video signal is passed to the program video unscrambler 62 of the program signal unscrambler 24. The program signal unscrambler 24 “operates in response to control signals from the control and storage unit 26 to unscramble the incoming program signal and provide unscrambled audio and video signals UAUD [“a second portion of said stream of digital data”] and UVID to a conventional modulator 28” [Block at 3:62-4:9 (emphasis added)]. APOSITA would have understood that, because program video unscrambler 62 is controlled by control signal VCS' from control and storage

unit 26, Block renders obvious controlling the passing of a second portion of said stream of digital data among said plurality of programmable processors.

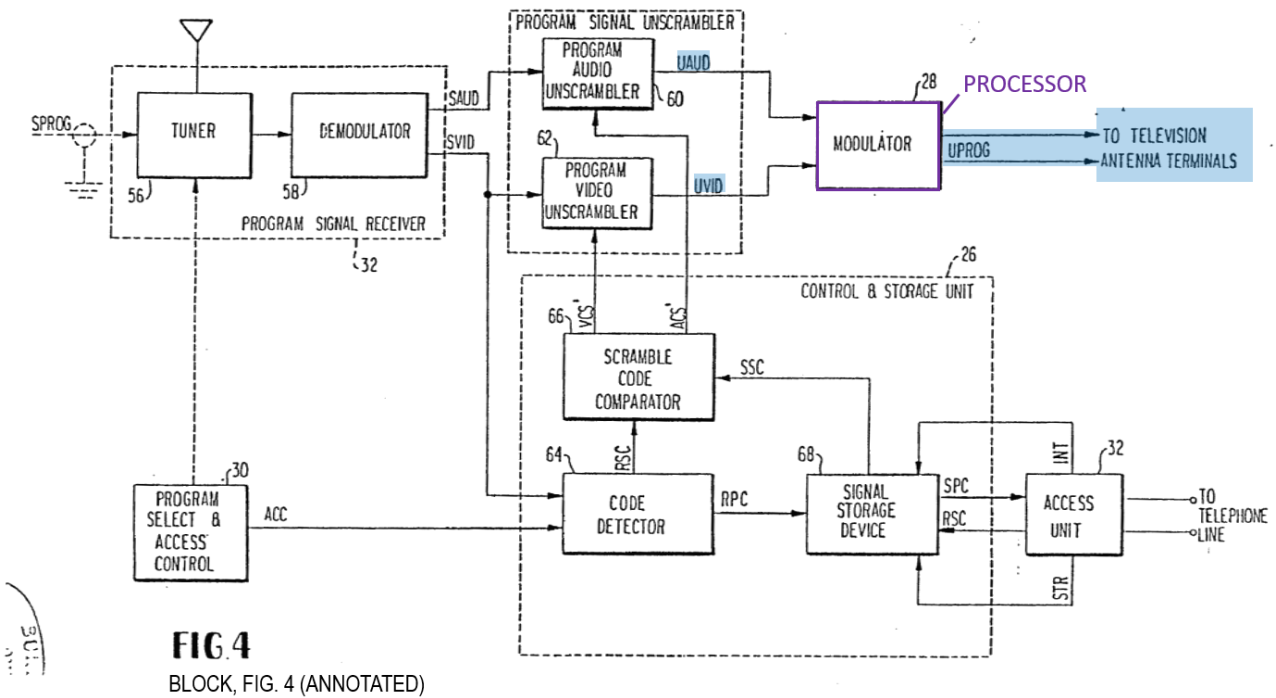


254. Block's description of the passing of the unscrambled video signal ["a second portion of said stream of digital data"] from the program video unscrambler 62 to the modulator 28 ["[a] programmable processor"] in response to the VCS' teaches passing a second portion of said stream of digital data in a second passing fashion.

255. Thus, Block renders obvious controlling the passing of a second portion of a stream of digital data in a second passing fashion in response to a passed control portion [Block at 3:62-4:9].

“processing said passed second portion of said stream of digital data to output image information from said plurality of programmable processors to an information output device.” (element at 106.9)

256. “[T]he scrambled program signal SPROG” of Block is sent to a program signal unscrambler 24 [“[a] programmable processor”] and to a control and storage unit 26 [“[a] programmable processor”] [Block at 3:62-4:9]. The program signal unscrambler 24 [“[a] programmable processor”] “provide[s] unscrambled audio and video signals UAUD and UVID to a conventional modulator 28” in response to control signals from control and storage unit 26 [“[a] programmable processor”] [Block at 3:62-4:9]. Modulator 28 “modulates a carrier signal of an appropriate carrier frequency with the unscrambled audio and video signals [“said passed second portion of said stream of digital data”] and supplies the unscrambled program signal in the form of a modulated carrier wave to the television set in a conventional manner” [Block at 3:62-4:9 (emphasis added)].



257. Thus, through its description of modulating the unscrambled video signal UVID [“said passed second portion of said stream of digital data”], Block teaches processing said passed second portion of said stream of digital data.

258. APOSITA would have understood that, because the unscrambled video signal UVID contains video information, which includes image information, Block describes processing a signal and outputting image information through its description of modulating the unscrambled video signal UVID and providing the modulated carrier wave to a television set.

259. APOSITA would understand that a television set is an information output device. Thus, through its description of modulating unscrambled audio and video signals [“said passed second portion of said stream of digital data”] and

providing the modulated carrier wave [“processed information”] to a television set [“an information output device”], Block at least renders obvious processing a second portion of a stream of digital data to output image information from a programmable processor to an information output device [Block at 3:62-4:9].

VIII. Conclusion

260. I currently hold the opinions set expressed in this declaration. My analysis may continue, however, and I may acquire additional information and/or attain supplemental insights that may result in added observations, and I therefore reserve the right to amend or supplement this Declaration in the event that new information becomes available to me.

261. I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare 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 the Title 18 of the United States United States Code.

Signature: /John Villasenor/
John Villasenor

Date: November 17, 2016

APPENDIX

The EBU C-MAC/Packet System for Direct Broadcasting by Satellite

HENRI MERTENS AND DAVID WOOD

Abstract—After three years of research and development work conducted by an international team, the EBU has recommended the adoption of a system termed "C-MAC/packet," for direct satellite broadcasting using 625-line television standards. This system is based on the generalized use of time-division multiplexing, the sequential transmission of time-compressed luminance and color-difference components, and the principle of packet multiplexing for sound and data broadcasting services. This system will permit an appreciable improvement to be made in the quality of the picture and sound, together with an increased quantity and diversity of services offered to the public. This article explains the technical principles of the system.

I. INTRODUCTION

SATELLITE broadcasting services for Europe at 12 GHz are governed by the WARC-BS '77 Plan. Generally, this plan permits European countries up to five 27 MHz satellite broadcasting channels. The plan was based on a reference system of a conventional analog television plus one analog sound channel, but it made allowance for later developments by permitting alternatives, provided that they do not cause more interference than the reference system.

EBU specialists have developed a new system which can use the WARC-BS '77 channels, having significant advantages over the reference system. It permits up to eight high-quality digital sound channels to be transmitted, in addition to an analog television signal with a quality approaching the recently agreed digital studio standard (CCIR Recommendation 601). It is designed to permit flexibility in the future and to cope with all the current requirements of European broadcasters for sound channel capacity.

The specification was prepared by the EBU Technical Committee and was submitted to the Interim Meetings of the CCIR in September 1983. It should be a major step in the evolution of broadcasting technology and will undoubtedly have consequences for the future of broadcasting, both space and terrestrial.

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This paper presents some of the fundamental features of the system, known as "C-MAC/packet," which is also the subject of a detailed specification issued by the EBU [1].

II. THE UNDERLYING PRINCIPLE OF THE SYSTEM: TDM

In the past there has been a one-to-one relationship between RF channels and broadcast services: each channel has been used for a single service, such as a radio program or a television program, the latter in the form of a picture plus one or two accompanying sound signals. The first notable exception to this practice was the introduction of teletext services, incorporated in the field-blanking interval of the television waveform. At the present time there are many projects for the broadcast transmission or cable distribution of *auxiliary* or *supplementary* services (see CCIR Report 802); most of these are, in fact, data broadcasting services.

The C-MAC/packet system brings with it the complete abandonment of this one-to-one relationship between channels and services. It is designed to provide for the variable and evolutionary broadcast transmission of a group of services within the limits of a channel defined for satellite broadcasting by the WARC-BS '77. The broadcast signal will therefore be made up of analog or digital components, the combined use of which constitutes one or the other of the specific services; for example, television service will be made up from the video luminance and color-difference components, plus a monophonic or stereophonic main sound channel, and perhaps a variety of other associated sound channels, such as commentaries and even several sets of subtitles.

Three types of services have so far been identified and have become operational in broadcasting: television, radio, and teletext. Nevertheless, if we consider the enhanced levels of the latter, including alphanumeric and alphaphotographic coding and all the other data services now being developed, we arrive at a large number of possible combinations of the following basic components: moving pictures, text and graphics, still pictures, sound with a variety of quality levels, and several kinds of data. Therefore, the basic objective of the system is to ensure *flexibility* in the way these components are brought together to form specific services.

The most demanding component, as far as capacity is concerned, is the television picture. Therefore, the system has been developed around the need for broadcast transmission of high-quality moving pictures. In particular, the signal structure continues to be founded on the principles of 625 lines and 2:1 interlacing. Furthermore, the picture continues to be transmitted in analog form as there are, as yet, no known bit-rate reduction techniques which are economically acceptable for use in domestic receivers and which could serve in the digital transmission of picture signals with a bit rate on the order of 20–25 Mbits/s, which corresponds to the maximum capacity available in a WARC-BS '77 satellite channel. Finally, for reasons considered in greater detail in Section IV, a choice has been made in favor of a system in which the luminance and color-difference components are transmitted separately (the MAC system), which serves to eliminate the inherent defects of composite coding systems such as NTSC, PAL, or SECAM.

In contrast, digital sound techniques have now been mastered and are accessible to the general public, which is therefore able to take advantage of the corresponding improvement in quality (increased dynamic range, absence of distortion, etc.). Digital techniques are also, of course, the best suited for transmission of data.

The fundamental problem in devising the system was how to multiplex the digital and analog components in variable proportions. Frequency-division multiplexing (FDM) is one way, but in fact, the general principle of time-division multiplexing (TDM) was preferred because it offers greater capacity, increased flexibility, and the elimination of intermodulation phenomena in the satellite channel, which it will be recalled, is highly nonlinear.

The signal for a normal television transmission, accompanied by other services, is described by Figs. 1 and 2, which show, respectively, the structure of one 64 μ s scanning line and one complete frame of 625 lines, the total duration of which is therefore 40 ms.

This structure is based on a clock frequency of 20.25 MHz, chosen for the following reasons.

1) For the digital components, a bit rate of 20.25 Mbits/s is close to the capacity limit of the 27 MHz satellite channel when four-state phase-shift keying is used.

2) For the analog picture components, the ratios between the clock frequency and the luminance and color-difference sampling frequencies defined in the digital video standard for studios (i.e., 13.5 and 6.75 MHz as set forth in CCIR Recommendation 601) are equal to the temporal compression ratios of these elements (3:2 and 3:1, respectively, as discussed in Section IV; the digital production standard and the analog broadcasting standard are therefore matched, the latter being "transparent" to the quality accommodated by the former.

Given these conditions, each line contains a total of 1296 clock periods which, leaving aside those periods reserved for transitions between service components and for auxiliary purposes, are used in normal operations for the transmission of:

1) a digital burst of 203 bits; 195 of these carry useful information, corresponding to a mean bit rate of about 3 Mbits/s; and

2) in turn, the analog color-difference components (354 clock periods) and the luminance component (704 clock periods).

In fact, the intervals allocated to each element have these values only in the case of normal video conditions; the intervals can in effect be modified in both the horizontal sense (length of a component in the line) and in the vertical sense (number of lines used for that component within each frame). These intervals are governed by the time-multiplex control data, which are transmitted in the special data burst which occupies the whole of line 625 (see Section VII). In particular, it is possible to lengthen the digital burst to the point where full-channel data are transmitted or, alternatively, to shorten it with a view, for example, to altering the aspect ratio of the picture.

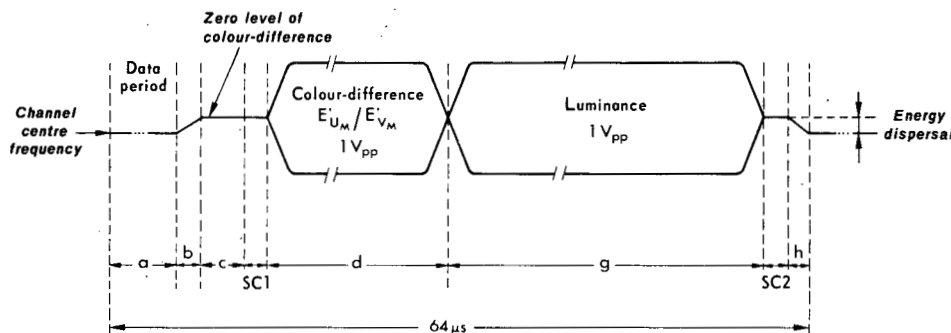


Fig. 1. Normal waveform of the time-multiplexed signal on one scanning line (not to scale).

- | | |
|-------------------------|---|
| $a = 203$ bits | synchronization, sound/data; |
| $b = 4$ clock periods | transition from end of data; includes the leading edge of a pedestal signal added to the video to provide energy dispersal; |
| $c = 15$ clock periods | main clamping period; |
| $SC1 = 6$ clock periods | reserved for vision encryption; |
| $d = 354$ clock periods | color difference; |
| $g = 704$ clock periods | luminance; |
| $SC2 = 6$ clock periods | reserved for vision encryption; |
| $h = 4$ clock periods | transition to data; includes the trailing edge of a pedestal signal added to the video to provide energy dispersal. |

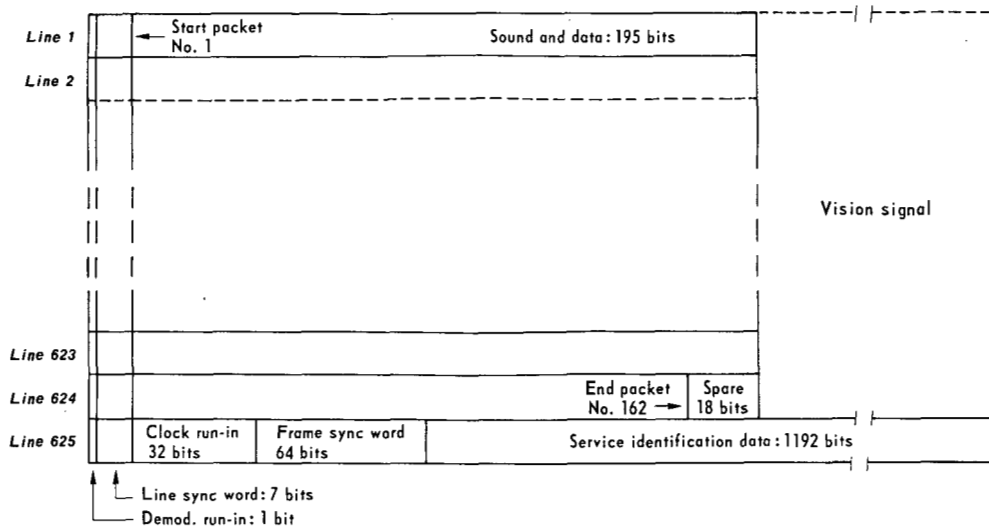


Fig. 2. Normal structure of a digital frame of 625 lines, organized as a time-division multiplex (not to scale).

It may be noted, finally, that synchronization for the system is entirely digital. It is achieved by recognition, either separately or together, of a line synchronization word of 7 bits and a frame synchronization word of 64 bits inserted in line 625. Additionally, spectrum shaping is applied by means of pseudorandom scrambling of the digital data, and these are then interleaved to avoid the occurrence of double errors after differential demodulation (see Section III).

The basic principle of the system is therefore seen to be the generalized adoption of TDM, in which the analog components are themselves transmitted in a time multiplex (MAC system) and the digital components are sent in a packet multiplex as described in Section IV.

III. MODULATION METHODS FOR SATELLITE BROADCASTING AND CABLE DISTRIBUTION

A. Satellite Broadcasting

The system has been developed primarily with a view to its implementation in satellite broadcasting services using 27 MHz channels. It was therefore natural to adopt frequency modulation for the analog components, with characteristics identical to those indicated in the Final Acts of the WARC-BS '77 including, in particular, a frequency deviation of 13.5 MHz/V. As is generally known, frequency demodulation can be achieved either with a conventional demodulator or with one employing threshold-extension techniques.

The problem was more complex with respect to the digital elements, and a choice had to be made, in two families of systems referred to as type B and type C, and between frequency-shift keying (FSK) and a number of variants of four-state phase-shift keying [2]–[4].

The choice finally fell on 2–4 PSK modulation [5], [6] in which the change in carrier phase is instantaneous and

equal to $\pm 90^\circ$ for each bit; this offers the following advantages.

1) The spectrum shape is suitable and there is little spectrum spreading owing to its near-constant envelope, after passing through nonlinear equipment such as a satellite transponder operating at saturation.

2) The simplicity and good performance of differential demodulation; in this method, after the receiving filter, which has the purpose of maximizing the carrier-to-noise (C/N) ratio, the signal is divided between two channels: one is subjected to a 1 bit delay and the signals are then multiplied together.

3) Improvement in performance of about 1 dB by using coherent demodulation, at the cost of a slightly more complex receiver (a reference carrier is included for this purpose on line 624).

4) Possibility of using the same FM demodulator as for the analog components, if the C/N ratio is sufficiently high.

The modulation is therefore type C, in which the time multiplexing of the analog and digital components is done at radio frequency.

B. Cable Distribution

The complete TDM can nevertheless be transmitted using modulation methods different from those mentioned above, and this will be the case, in particular, on the large cable networks where a bandwidth as large as 27 MHz would be unacceptable. Studies on this aspect are not yet complete [7], but attention is being turned towards vestigial-sideband amplitude modulation (AM-VSB), with or without carrier, and with the digital components transmitted in duo-binary form. The bandwidth requirement if such systems are adopted then comes down to under 14 MHz, and the TDM can be done in the baseband. It must be emphasized that apart from this difference in modulation (and the substitution of the appropriate demodula-

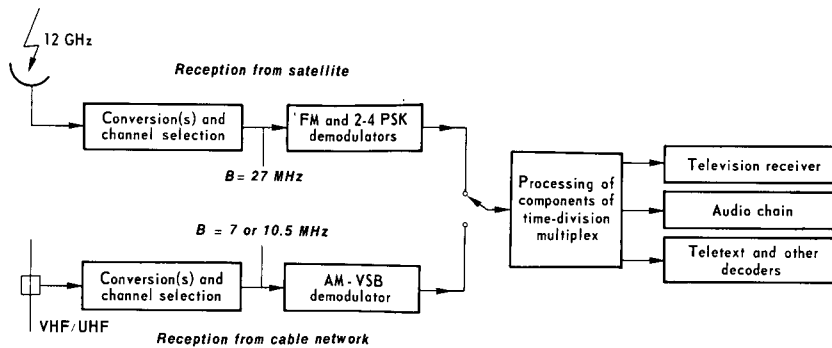


Fig. 3. Simplified diagram showing common elements of the receiver in the case of satellite broadcasting and for cable distribution.

tor), the system remains entirely unchanged, and so all the receiving circuitry following after the demodulator is the same as for direct reception from a broadcasting satellite. Furthermore, all the properties of the TDM are retained, including quality, capacity, and service flexibility. These characteristics are illustrated in Fig. 3 where it is seen that only the receiver input stages (antenna, feed from the cable, frequency converter, channel selection, and demodulator), have to be changed when transferring from direct satellite reception to cable distribution services. In the latter system the existing frequency channel plans in use on the cable networks would, however, have to be modified.

The case of community reception of satellite transmissions with small collective-antenna systems will not be discussed in detail here. The most generally envisaged solution for such cases is to distribute the signals in the form in which they are received from the satellite, but in the band used for the first intermediate frequency (950–1750 MHz).

IV. IMAGE CODING USING MAC

The principles of the MAC video coding system have been described in various publications [8]–[10]. The EBU specification adheres to these general principles, and incorporates several improvements.

The starting point is the digital video standard for studios, known as the 4:2:2 standard, based on the use of separate Y , U , and V components for the image (CCIR Recommendation 601), in which the maximum bandwidths of the luminance and color-difference signals are about 6 and 3 MHz, respectively. The MAC system is designed to transmit the quality corresponding to these bandwidths, although the bandwidth of the color-difference signals may have to be reduced to about 2 MHz in the receiver to limit the effects of noise. This will have hardly any effect on the final quality of natural pictures because of the limited color acuity of the human eye.

The luminance signal is time compressed on a line-by-line basis, in the ratio 3:2, and the bandwidth it occupies in the transmission channel is therefore increased in the same proportion. The compression is achieved by digitally sam-

pling the signal, which then loads a line store; this is read out at a higher frequency than the input and the signal is then restored to analog form.

The color-difference signals are subjected to time-compression of similar form, but this time the compression ratio is 3:1; the color-difference bandwidth therefore remains equal to one half of that of the luminance, as in the 4:2:2 digital standard.

The luminance and color-difference signals are then arranged side by side in a single television line and are thus transmitted as a time multiplex (Fig. 1). The result is that the cross-color and cross-luminance effects inherent to the PAL and SECAM systems are eliminated. The final bandwidth of the MAC signals is 1.5 times that of the luminance signal at the picture source.

The color-difference signals are transmitted alternately on successive lines; in other words, it is a line-sequential system. One result of this is that the horizontal and vertical resolutions are approximately matched for the luminance and color-difference information. Nevertheless, the color-difference signals are produced by a more complex method than the simple omission of every other line or the calculation of the mean of two adjacent lines. A *vertical filtering* algorithm is used to obtain a frequency response, which reduces aliasing in the vertical spectrum. The algorithm proposed for prefiltering at the transmission end generates one color-difference line from the weighted addition of seven successive lines. The postfiltering algorithm used in receivers can be simpler and may, for example, process only three lines at a time.

It should be noted that a system in which two color-difference signals are transmitted on every line would simplify the vertical aliasing problem, but the noise performance would be unacceptable, owing to the increase in compression ratio that would be needed and the corresponding reduction in deviation in the FM signal.

As shown in Fig. 1 the luminance and color-difference signals have the same maximum amplitudes and therefore give the same frequency deviation (from black to white for the luminance and up to 77 percent electrical saturation for the color difference).

The large amount of preemphasis needed in the frequency-modulated transmission of PAL and SECAM

signals is unnecessary with the new system. Some degree of preemphasis can nevertheless help to improve the performance as regards interference and high-frequency noise.

Several methods may be used in the future to enhance the picture resolution. One of these is based on energy spectrum folding by down sampling [11]. These techniques may be developed once low-cost frame stores become available for use in receivers.

Summarizing, it may be said that the MAC system is a time multiplex of time-compressed luminance and line-sequential color-difference signals. Its principal advantages are an improvement in quality, resulting from the elimination of cross color and cross luminance and the increase in component bandwidths, together with improved RF performance in frequency modulation and great flexibility as regards future enhancements.

V. DIGITAL SOUND CODING

The EBU's experts have been studying baseband coding for digital sound for several years [12]–[15]. Subjective evaluation has shown that an audio bandwidth of more than 15 kHz offers no significant improvement in quality. This 15 kHz bandwidth may be obtained using a sampling frequency of 32 kHz, without the receiver filters being excessively complex. It has also been shown that coding with 14 bits/sample provides a dynamic range which is not worth exceeding for domestic listening conditions. These two factors therefore form the basis of the digital sound coding system recommended for satellite broadcasting (see CCIR Report 953).

Where it is important to reduce the bit rate, as a means of increasing the number of sound channels, consideration also has to be given to companding systems, which offer bit-rate economy at the expense of program-modulated noise, but which must remain acceptable. Studies have been concerned with several methods, and it has been concluded that the most effective is near-instantaneous 14–10 bit companding with five compression ranges coded using a "scale factor"; with this method, the program-modulated noise is inaudible, except during certain especially critical sound passages.

As explained in Section VI, the flexibility of the digital multiplex is such that the nature of the services can be modified on demand. For the sound services, four configurations have been selected, these corresponding to the main types of sound broadcasting likely to be used in the years to come. Each possibility offers special advantages, and broadcasters will have to examine each of them and then decide which is the best suited to each of their particular national requirements. It is nevertheless hoped that receivers will be equipped in such a way that they will automatically recognize which of the four systems is in use, thus permitting the reception of programs from foreign countries or changes of configuration within a given channel to suit the particular content of the programs being broadcast in that channel at any time. The four configura-

tions in question are the following; the manner in which they are incorporated within the multiplex is described in Section VI.

a) High-quality sound with 32 kHz sampling, near-instantaneous 14–10 bit companding and error protection using 1 parity bit covering the 6 most significant bits of each sample (first-level protection).

The 3 bit scale factor applies to 32 consecutive samples; it is not transmitted separately, but instead by using the parity bits themselves (this parity-signaling technique is based on majority decision logic at the receiver, which processes three groups of nine samples and serves to recognize simultaneously the "even" or "odd" parity of the samples and the scale factor). It is this configuration which, for a given bit rate, offers the largest number of sound channels.

b) High-quality sound with 32 kHz sampling, near-instantaneous 14–10 bit companding and error protection using an extended Hamming code (11,6) in which the 5 protection bits enable the correction of one single error and the detection of one double error in the 6 most-significant bits of each sample (second-level protection).

The scale factor is again signaled in parity. This configuration has improved error protection as compared to the first case above, and this ensures the maintenance of adequate service quality at higher bit error rates, although the bit rate needed for each channel is larger.

c) High-quality sound with 32 kHz sampling, linear 14 bit/sample coding and error protection using 1 parity bit covering the 8 most-significant bits of each sample (first-level protection).

A scale factor defining 7 amplitude ranges for a group of 32 samples is again transmitted in parity. This scale factor is not essential for the decoder, as in the companded system, but it does enable the receiver to recognize and conceal an error, which is observed as a "click" when the noise is such that the amplitude falls outside the range signaled by the scale factor. It was the NHK which drew the attention of the EBU to this additional method of error concealment in linearly coded signals. In comparison to Case a), the sound quality is better, owing to the use of linear coding, but the bit rate needed for each channel is larger.

d) High-quality sound with 32 kHz sampling, linear 14 bit/sample coding and error protection using an extended Hamming code (13,8) in which the 5 protection bits enable the correction of one single error and the detection of one double error in the 8 most-significant bits of each sample (second-level protection).

A scale factor is again transmitted, with the same purpose as in Case c). This time the sound quality and the error protection are both greater, but this configuration consumes the largest bit rate per channel.

It is to be noted that in the four configurations described above, control information is also transmitted with the scale factor, in parity or in a free part of the coding block; this information operates a fast-acting switch (for example, speech/music), governing one of the sound characteristics

coded in the service-identification system (Section VII).

In every configuration the concealment of all errors that are detected, but not corrected, is done by replacing the erroneous sample by the mean of the two adjacent samples or, sometimes, by extrapolation.

Finally, it is possible in each configuration to replace a high-quality sound channel by two or three channels with smaller bandwidth, for commentaries for example, through the use of a sampling frequency which is a submultiple of 32 kHz.

VI. PACKET MULTIPLEXING OF THE DIGITAL SIGNALS

In the multiplexing system described in this article, which has been developed very largely in France by the CCETT [15], the signals corresponding to the digital services components (sound and data) are carried using the so-called "packet" multiplexing technique. The bit stream is made up of packets of fixed length, which comprise two parts:

1) first the *header*, which in turn contains an *address*, a *continuity index*, which serves to link together those packets sharing the same address, and a *suffix*, which serves to protect against errors; and then

2) a *useful data area* which, in the case of sound channels, starts with a *packet type* byte, the purpose of which will be considered later.

A digital channel carries the signal corresponding to a single service component; it is formed by all the packets having the same address, and it is recognition of this address which enables the receiver to identify and select the required service. The packet transmission rate within a given service is related directly to the bit rate of the corresponding signal at the input to the multiplexer, although it bears no special relationship to the final bit rate, with the result that synchronous or asynchronous operation may be adopted.

At the input to the multiplexer, the data corresponding to specific channels are stored in buffer memories. Each time it is ready to build a packet, the multiplexer examines the buffer memories (in an order of priority which depends on the continuity needs of the services), and it selects the data in a memory which contains sufficient data to fill a packet.

At the receiver, the packets are steered, by address recognition, to the appropriate decoders. In general, the data will again be passed via buffer memories, which will read out at the appropriate speed to reconstitute a continuous bit stream for the channel in question.

Several digital channels, and hence several services or service components, may therefore coexist in the multiplex, provided that the system capacity, fixed by the maximum overall bit rate, is not exceeded. The content of the multiplex, and hence the number and nature of the broadcast services, can be modified at any moment in time.

The packet structure that has been chosen is depicted in Fig. 4. It comprises the following areas.

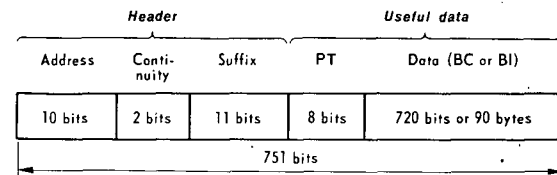


Fig. 4. Packet structure. The packet-type byte PT is inserted in packets carrying sound services to distinguish between BC's and BI's. For other types of services, the data area extends over 91 bytes.

1) **Address:** 10 bits; this is sufficiently long to permit the simultaneous coding of as many as 1024 services or service components.

2) **Continuity index:** 2 bits; a break in the sequence of this index enables the receiver to detect the loss of any packets that may be caused by erroneous address recognition.

3) **Protection suffix:** 11 bits; this suffix provides a high degree of protection for the header through the use of the Golay (23, 12) code which permits the correction of up to 3 errors in 23 bits.

4) **Packet-type (PT) byte** (for sound services only): this byte can adopt four values, which are separated by a Hamming distance of five; two of these values (which are used alternately) indicate that the subsequent data belong to a *coding block* (BC) containing audio samples; the other two values denote *interpretation blocks* (BI) which are transmitted at a low rate (1–3 times per second and per channel) and contain coded data indicating the nature of the sound coding (see Section VII).

5) **Data:** for the sound services, this area contains 720 bits or 90 bytes; it may be extended to 91 bytes (taking in the PT byte) in other services for which the coding methods have not yet been defined.

As shown in Fig. 2, a total of 162 packets is transmitted in each 625-line digital frame, this giving a rate of 4050 packets/s, or taking account of all 751 bits of each packet, a bit rate of 3.041550 Mbits/s. This capacity can be used in any required manner, as and when appropriate. We give below some examples of multiplex loads involving high-quality monophonic sound channels (32 kHz sampling) using linear coding or companding, and with first-level or second-level protection.

Referring to the description of the coding given in Section V, we will first summarize the numbers of bits (including the parity bits) used for each sample, and we will examine how the sound coding blocks are formed in the various cases. The different configurations are the following:

1) **Linear coding and first-level protection:** 15 bits/sample; a 120 byte coding block is built containing 64 samples; three coding blocks, each of 120 bytes, are then inserted in the 90 byte data areas of four successive packets.

2) **Companded coding and first-level protection:** 11 bits/sample; a 90 byte coding block is built containing 64 samples (with an area of 16 bits that remain unallocated); this coding block fits into a single packet.

3) **Linear coding and second-level protection:** 19 bits/sample; a 90 byte coding block is built containing 36

TABLE I
PACKET RATES AND BIT RATES FOR ONE HIGH-QUALITY
MONOPHONIC CHANNEL

Type of coding and level of protection	Bits per sample	Samples per packet	Packets/s (with BI blocks)	Bit/s
Linear 1st level	15	48	669 2/3	502.919 2/3
Companded 1st level	11	64	503	377.753
Linear 2nd level	19	36	891 8/9	669.808 5/9
Companded 2nd level	15	48	669 2/3	502.919 2/3

samples (with an area of 36 bits that remain unallocated or which are used for control information and a part of the scale-factor information); this coding block fits into a single packet.

4) *Companded coding and second-level protection*: 15 bits/sample; a 120 byte coding block is built containing 64 samples; as in the first case described above, three coding blocks are shared between four packets.

We can now calculate the packet rates required for one monophonic channel of each of the types under consideration, these always containing 32000 samples/s. To arrive at the total bit rate, we must nevertheless add the BI's which in normal operations, require 3 packets/s. Table I summarizes these results and also shows the bit rates per monophonic channel on the basis of 751 bits/packet.

From these figures it is possible to evaluate the maximum capacity of the multiplex in terms of numbers of monophonic channels of different types. The results are shown in Table II, which shows the packet rates needed for the numbers of channels indicated and the residual packet rate available for other services including the dedicated service-identification channel discussed in Section VII. It will of course be appreciated that the removal of one sound channel makes available an equivalent additional capacity for data services.

VII. SERVICE IDENTIFICATION

A. General

The multiplicity of services or service components which can be broadcast simultaneously in a single channel, either in the form of components of the TDM or within the packet multiplex, requires the provision of an identification system which serves to help users gain rapid access to the wanted service. This service-identification system must therefore offer:

- 1) a readily obtained list of available services;
- 2) a means for automatically configuring the receiver and its decoders to suit the choice made by the user; and
- 3) a rapid indication of which service is in fact being received.

These requirements have resulted in the development of an elaborate system, the details of which are beyond the

TABLE II
MAXIMUM CAPACITY OF THE MULTIPLEX, EXPRESSED IN TERMS OF
MONOPHONIC CHANNELS, AND RESIDUAL CAPACITY AVAILABLE
FOR OTHER PURPOSES

Type of coding and level of protection	Capacity needed for sound channels (packets/s)	Residual capacity (packets/s)
6 linear channels 1st level	4018	32
8 companded channels 1st level	4024	26
4 linear channels 2nd level	3567 5/9	482 4/9
6 companded channels 2nd level	4018	32

scope of this paper to describe. We will restrict ourselves to only mentioning the various data which are broadcast as a function of the selected transmission mode.

B. Special Data Burst in Line 625

The whole of line 625 is reserved for a special data burst, which in addition to serving for frame synchronization purposes, contains the following main items of information.

- 1) Universal date and time information in a form intended to be read and processed by machines; this includes the Modified Julian Date and Coordinated Universal Time, with indications of local time offsets.
- 2) A coded identification of the satellite channel.
- 3) Abridged information about the TDM configuration, including in particular whether or not the signal is being transmitted in accordance with the normal conditions corresponding to Figs. 1 and 2 (MAC picture signal, digital burst of 203 bits/line, etc.).
- 4) Detailed information on the structure and control of the TDM, indicating in particular the position occupied by each component of the multiplex, in the horizontal sense (number of clock periods along the line) and in the vertical sense (number of lines used); it is these data which provide the TDM with its flexibility and which make it possible to use it for new applications such as full-channel data broadcasting, changes in picture aspect ratio, etc.

C. Dedicated Digital Channel in the Packet Multiplex

One digital channel, made up of all the packets bearing the address "O," is reserved for the identification of the services carried in the packet multiplex. The coding structure is that recommended in CCITT Recommendation S.62 for teletext control. The transmitted information includes coded indications and also clear-language text, of variable length, which may be displayed on the television receiver screen or on a special display device. These include the following main indications.

- 1) Origin and name of the program network, in the form known to the public.
- 2) Local time, in a form suitable for display.
- 3) A list of available services, including for each of them the name of the service, the type of program, and the

number and name of the program item (the program item number is a code indicating the data and time at which it is intended that the item should be broadcast).

4) Video signal coding and possibly the configuration of an analog sound element; the absence of this code signifies that the picture is broadcast using the MAC format and that there is no analog sound.

5) Information on the digital components, including for each of them an indication of the language used and the access coordinates (i.e., in effect, the address of the corresponding packets).

6) Updating messages indicating changes in the content of the program network.

7) Various clear-language commentaries, which may be supplemented by additional information carried in a teletext magazine.

For a typical example in which the channel carries a television program with original sound, three commentary sound signals, and subtitles in three different languages, together with two radio services and four different teletext services, the bit rate needed in the dedicated channel is on the order of 12 kbits/s or 16 packets/s.

D. Digital Service Channel

The information transmitted at this level is concerned only with a service or service component (and hence, with a single decoder), and it is carried in the same digital channel as the service itself, i.e., it uses packets bearing the same address as the service. The indications have not as yet been defined other than for the sound services. They are built up using BI's mentioned in Section VI and are distinguished from coding blocks by the PT byte. These interpretation blocks normally have a length of one packet, and for each sound channel, they are normally transmitted at a rate of between 1 and 3 blocks/s. If the service configuration is modified, they are transmitted more often, and the precise instant of any switching that may be required (speech/music, for example) is signaled by the control information transmitted in the sound coding blocks.

The main information coded in the interpretation blocks is the following:

- 1) audio bandwidth (or sampling frequency);
- 2) monophonic or stereophonic sound;
- 3) linear or companded coding;
- 4) first- or second-level protection;
- 5) music or speech; and
- 6) various types of updating information, alarms, etc.

E. Error Protection and Access Time

For all the service-identification data, which must necessarily be repeated, error protection can be provided by the use of majority-decision logic. The access time then depends on the repetition rate of the data and the receiving conditions: the worse the conditions (i.e., the higher the bit error rate), the longer the access time. Additional protection and precautions, which we will not discuss in detail here, have therefore been introduced; these include:

1) a cyclic redundancy check on the data blocks in line 625;

2) Hamming coding for several bytes related to data transmitted in the dedicated channel and for the interpretation blocks; and

3) the introduction of a continuity index and a protection suffix in the data groups in the dedicated channel, together with a limitation on the length of these data groups.

Taking account of all these methods, it is estimated that the time taken for acquisition of the data in line 625, including the satellite channel information and synchronization, will be about 0.1 s if the bit error rate is 10^{-3} . Once the satellite channel data have been acquired, the time taken to gain access, via the dedicated channel, to a known service will typically be 0.6 s.

VIII. GENERAL RECEIVER STRUCTURE

The C-MAC/Packet receiver has, at its input, an RF input section, which was described briefly in Section III and in Fig. 3. These input stages are specially suited to the transmission frequency band and the modulation system used and are not the same for direct reception from a satellite as for cable distribution.

The next section of the receiver, which we will call the *interface unit*, is the same for all situations; this unit contains the hardware for processing components of the TDM, and it delivers the appropriate signals to the "peripherals," i.e., the television receiver, hi-fi audio system, teletext decoder, etc. It is this interface unit which we will briefly describe here.

Using modern technologies, the signal processing hardware will take the form of integrated circuits, whose cost will be reasonably low provided that they are mass produced (which requires that the standard be applied generally, at an international level). It is believed that the complete receiver (including the RF stages) will need seven or eight integrated circuits, together with a microprocessor and memories, in order to provide one video output and one stereophonic audio output. The circuits used for picture processing will constitute only 20–30 percent of the total, the remainder being used in the RF stages and in the processing of the sound and data services.

The main functions are illustrated in Fig. 5 for the picture signal and a stereophonic sound program chosen from amongst the various channels carried in the packet multiplex. Several control functions are not indicated, for the sake of simplicity. Nor does the diagram show the decoding of the service identification in the dedicated channel of the packet multiplex, which controls the selection of the address of the wanted channel, or the connections to decoders for data services, such as teletext, which will be made after the data-rate converter.

This changes the bit rate from its instantaneous value of 20.25 Mbits/s to the mean value on the order of 3 Mbits/s, this latter figure being that found from consideration of the bits indicated in Fig. 2, which are transmitted in the

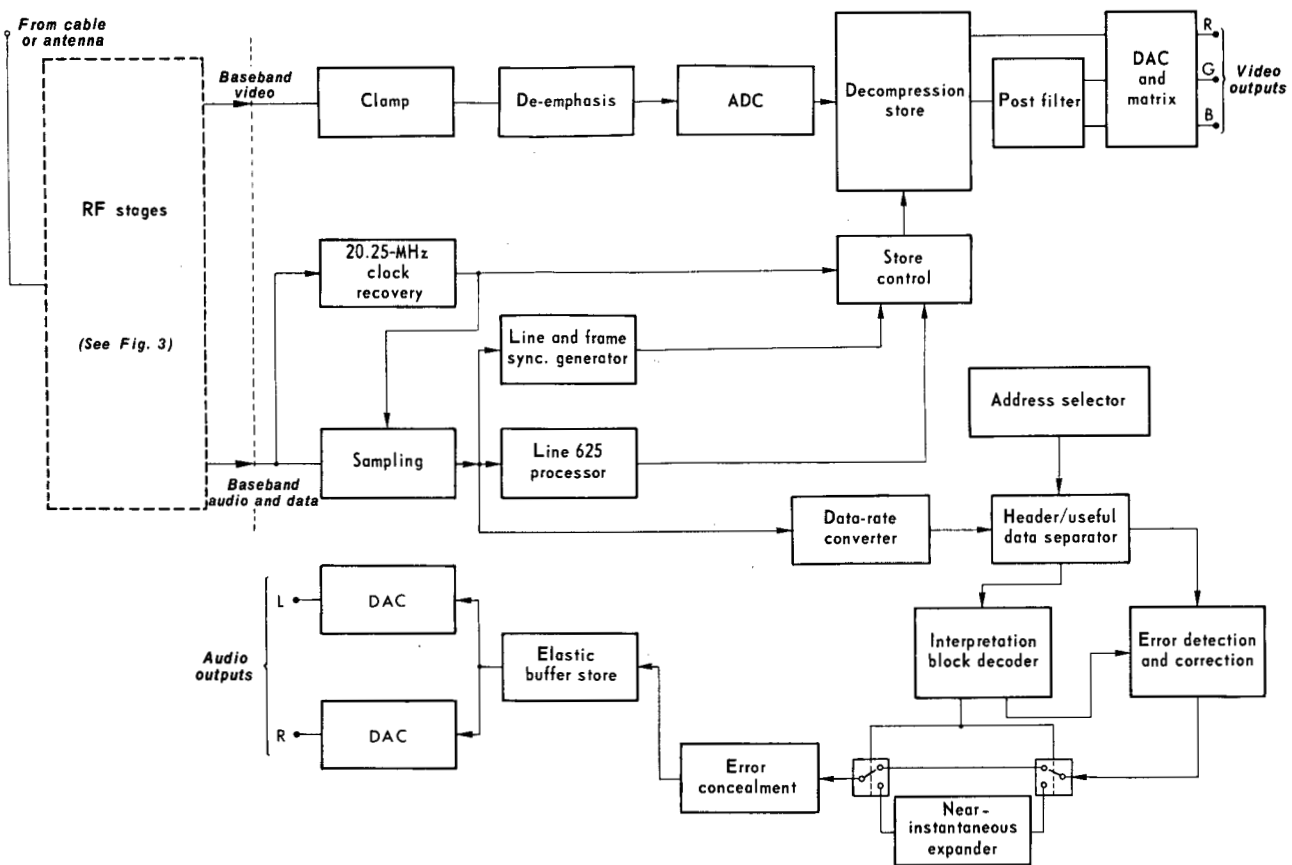


Fig. 5. Simplified diagram of the C-MAC/packet interface unit (several of the control and other functions are not included).

various lines to make up the packets. Finally, the diagram in Fig. 5 does not show the hardware for descrambling (spectrum reshaping) and deinterleaving the bits after demodulation.

To derive full benefit from the quality offered by the C-MAC/Package system, the television receiver must have baseband inputs for the Y , U , V or R , G , B components of the picture signal and baseband inputs for the sound signals. This possibility is provided for in growing numbers of television receivers equipped with the "peritelevision" connector, as it is termed in Europe. In the short term, nonetheless, for older receivers not so equipped, the interface unit will also have to supply a conventional composite video signal. (Of course, if the color components are used to generate a composite signal for display on such receivers, the cross-color and cross-luminance effects will be introduced at that point.)

IX. PERFORMANCE OF THE C-MAC/PACKET SYSTEM

Technical performance, which has been verified experimentally, is evidently one of the principal factors determining the choice of a new system. Two aspects need to be analyzed, these being the *basic quality* obtained when reception conditions are favorable and the *failure characteristic*, by which we mean the manner in which the quality is

degraded as the reception conditions become poor, which in satellite broadcasting, corresponds to a reduction in the C/N . This latter is dependent on the figure of merit (G/T) of the receiver (antenna diameter and noise factor) and on the position of the satellite receiver, whether it is well inside, on the edge, or on the outside of the nominal coverage area of the satellite.

It will be recalled that the assumptions adopted at the WARC-BS '77 were such that the coverage area was taken as being that zone at the edge of which the C/N ratio was 14 dB, for 99 percent of the time, with a receiver G/T of 6 dB/K. The basic quality will therefore be taken as that obtained with a C/N ratio of at least 14 dB.

As regards the sound, listening tests have shown that none of the forms of coding described in Section V results in any impairment perceptible to the ear within the dynamic range suitable for domestic listening conditions. No noise is audible on normal program material originating from high-quality sources, although the program-modulated noise is just perceptible with companded coding on very critical passages such as pure sine waves.

For the picture, the aim has been, as explained earlier, to offer quality very close to that of the 4:2:2 digital studio standard. Subjective evaluations have shown that the final quality is barely 0.1 grade (in the 5-grade quality scale) below that of the 4:2:2 digital standard where screens of conventional size are used. This means that it is virtually the quality of studio R , G , and B signals which are finally supplied to the viewer.

No evaluations have been made of MAC pictures displayed on large screens. Nevertheless, tests done in 1980 with a signal similar to the 4:2:2 digital standard showed that this could give a quality comparable to that derived from 16 mm motion-picture film. Hence, in view of developments in image processing technologies, there is every reason to be optimistic as regards domestic large-screen viewing of the broadcast pictures.

The *failure characteristic* takes on a different form for the analog components, for which the quality falls off gradually, and for the digital components, for which the service remains excellent down to a certain limit beyond which the degradation rapidly becomes severe.

In MAC pictures, the color-difference signals are not carried on a subcarrier, and hence the noise power per unit bandwidth is less than in the case of composite PAL or SECAM signals; it is therefore to be expected that the failure characteristic will slope off more gradually. This has indeed been confirmed in many subjective tests conducted by the EBU. The most significant of these tests were probably those in which, after passing through a nonlinear satellite simulator, the MAC picture and sound, with near-instantaneous companding and first-level protection, were shown simultaneously to observers. In these conditions, the first threshold effects (luminance spikes on the picture) were observed at a C/N ratio of 10 dB using a conventional demodulator and at a C/N ratio of 8–9 dB with a threshold-extension demodulator. The first audible clicks on the sound appeared at a C/N ratio of about 8 dB, using differential demodulation.

It must be stressed that, although these figures correspond to a perceptible impairment, the quality was nonetheless still adequate for a normal service. The service *failure point* itself was defined as the equivalent of grade 1.5 on the 5-grade impairment scale, i.e., halfway between "poor" and "bad." It is generally reckoned that it is at this point that users will cease to tolerate the lack of technical quality, even when the program is of great interest.

In the subjective tests we have already mentioned, the sound and picture failure points were evaluated in the presence of noise; in a real situation it would of course be necessary to also take account of any impairments caused by interference.

For pictures broadcast using MAC, the quality rating 1.5 was reached at a C/N ratio of 3 dB using a conventional demodulator and at 2 dB with a threshold-extension demodulator; these figures were about 2 dB below the failure points for pictures in PAL or SECAM. For sound signals using near-instantaneous companding, the quality grade 1.5 came at a C/N ratio of 4.5 dB with first-level protection. Second-level protection would give an improvement of between 1 and 2 dB.

Referring to the assumptions adopted at the WARC-BS '77 recalled earlier, it is seen that the coverage areas will be made very much larger through the combined use of modern receivers (where the figure of merit has been increased by 2–3 dB for a given antenna diameter) and the C-MAC/packet system, whose analog and digital compo-

nents have better noise performance than the reference system envisaged in 1977.

As regards interference, subjective tests have also shown that the C-MAC/packet system satisfies the conditions imposed by the WARC-BS '77 relating to protection ratios.

X. CONCLUSION

The EBU Technical Committee has developed a new system for direct broadcasting by satellite which is based on the TDM of digital and analog service components. The digital part of the multiplex provides sound and data services, and also control signals which define the structure of the multiplex. In this way, present and future flexibility is ensured since the receiver does not need to know *a priori* the overall composition of the service components.

The system has been developed over a number of years and has been the subject of experimental verification. This has shown that, apart from its additional capacity and flexibility, the system offers higher quality and an improved failure characteristic, compared to conventional systems. It also meets the appropriate interference requirements.

Please note that precise bit and sample period allocations given in this paper may be subject to updating following recent progress in cable distribution format studies.

ACKNOWLEDGMENT

The views expressed in this paper are those of the authors, but it must be stressed that the authors are not the inventors of the system. It was developed by a very large team of engineers from many EBU member organizations (too numerous to list and to acknowledge individually). Therefore, the system is actually the fruit of extensive international collaboration and cooperation.

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