

IPR2024-00935
U.S. Patent No. 7,865,177
Patent Owner's Response

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TEXAS INSTRUMENTS INC.,
Petitioner,

v.

PARKERVISION, INC.
Patent Owner

U.S. Patent No. 7,865,177

Issue Date: January 4, 2011

Title: METHOD AND SYSTEM FOR DOWN-CONVERTING AN
ELECTROMAGNETIC SIGNAL, AND TRANSFORMS FOR SAME, AND
APERTURE RELATIONSHIPS

Inter Partes Review No. IPR2024-00935

**PATENT OWNER'S RESPONSE TO PETITION FOR *INTER PARTES* REVIEW
OF UNITED STATES PATENT NO. 7,865,177**

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1.	Razavi does not disclose, teach, or suggest a “matched filtering/correlating module.”	100

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2.	Razavi does not disclose, teach, or suggest circuitry for down-converting an input signal “such that energy of the input signal is integrated and transferred to a load to form a down-converted signal.”	108
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TABLE OF AUTHORITIES

Page(s)

Cases

<i>ParkerVision, Inc. v. Qualcomm Inc.</i> , 621 F. App’x 1009 (Fed. Cir. 2015)	108
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PATENT OWNER'S EXHIBIT LIST

Exhibit No.	Description
2006	Court Order adopting Special Master's Report and Recommendation, dated January 21, 2025 (Dkt. 65) – CA No. 6:23-cv-00389 (WDTX)
2007	Court Claim Construction Order dated April 29, 2020 –No. 6:14-cv-687 (MDFL)
2008	RESERVED
2009	UA741 datasheet
2010	Boeing Report dated April 29, 1998
2011	ParkerVision schematic dated January 20, 1998
2012	Eddie chip layout dated March 6, 1997
2013	ParkerVision circuit board layout
2014	ParkerVision schematic dated August 21, 1997
2015	Conception/Reduction to practice chart
2016	Declaration of David Sorrells
2017	Proakis, J. et al., Communication Systems Engineering
2018	09/550,644 prosecution history excerpt
2019	ParkerVision Announces Breakthrough in Wireless Radio Frequency Technology
2020	Laboratory Tests Verify ParkerVision Wireless Technology
2021	Universal Direct Conversion Receiver Evaluation ASIC Contract between ParkerVision and The Boeing Company
2022	Notes from Boeing Tests
2023	Sklar B., Digital Communications Fundamentals and Applications
2024	Declaration of Dr. David Ricketts
2025	Excerpts from Howe, R. et al., Microelectronics: An Integrated Approach
2026	RESERVED
2027	Development Agreement between ParkerVision and TriQuint Semiconductor dated March 4, 1997
2028	Default Protective Order
2029	Spreadsheet showing ParkerVision files

2030	Claim Construction Order dated 2/20/13 – No. 3:11-cv-00719 (MDFL)
2031	Excerpt of Graf, R., Modern Dictionary of Electronics, Seventh Edition
2032	Rofougaran, A., et al., A 1 GHz CMOS RF Front-End IC for a Direct Conversion Wireless Receiver
2033	U.S. Patent No. 6,061,551
2034	Deposition Transcript of Ian Galton, dated March 12, 2025
2035	Special Master's Report and Recommendation Regarding Claim Construction, dated October 21, 2024 (Dkt. 45) – CA No. 6:23-cv-00389 (WDTX)

I. INTRODUCTION

This case relates to how wireless devices process radio signals. Specifically, claim 14 of U.S. Patent No. 7,865,177 (“’177 patent”) is directed to a method of down-converting an electromagnetic signal. The claim refers to a module called a matched filtering/correlating module that is used in the down-conversion process.

Claim 14 was conceived and diligently reduced to practice no later than early 1998. Thus, one of the cited references, Tayloe, is not prior art because Tayloe has a priority date of October 1998 – many months after ParkerVision conceived and reduced the claimed invention to practice.

With regard to the matched filtering/correlating module, Petitioner's claim construction is wrong. Not only is it ambiguous (referring to “similar” features), but it omits key concepts that Petitioner's own expert, Dr. Galton, admitted (at his deposition and in his declaration) were features of a matched filtering/correlating module. Dr. Galton inexplicably omitted these features from his construction.

Finally, the cited references (Tayloe and Razavi) do not disclose the claimed invention. Dr. Galton incorrectly describes the operation and/or configuration of these references. And his/Petitioner's analysis is based on this flawed understanding. Indeed, during his deposition, Dr. Galton made critical admissions demonstrating the flaws in his analysis.

For the forgoing reasons, Petitioner has failed to demonstrate that claim 14 is invalid.

II. LEVEL OF ORDINARY SKILL IN THE ART

A POSITA at the time of the invention of the '177 patent would have: (a) a Bachelor of Science degree in electrical or computer engineering (or a related academic field), and at least two (2) additional years of work experience in the design and development of radio frequency circuits and/or systems, or (b) at least five (5) years of work experience and training in the design and development of radio frequency circuits and/or systems. Ex.-2024, ¶30.

III. TECHNOLOGY BACKGROUND

A. Circuit concepts¹

Charge: Charge is a fundamental property of matter. There are two physical types of charge: positive and negative. Protons carry a positive charge (+), while electrons carry a negative charge (–).

Voltage: Voltage represents the difference in electric potential energy per unit charge between two points in a circuit. It quantifies the amount of potential energy available to move charges.

¹ Ex.-2024, ¶¶43-52.

Electric current: Electric current is the flow/movement of charge within a circuit (in a conductor or into, out of, or through an electrical component).

Electric energy: Electric energy is the capacity to accomplish work based on a quantity of electric charge and its related electric field. Energy is not the same as voltage.

Power: Power is the rate at which energy is transferred within a circuit, measured per unit time.

Resistance: Resistance is a measure of the difficulty of passing current through a conductor.

Impedance: Impedance is the measure of the opposition that a circuit presents to a current when a voltage is applied. A circuit component with high resistance has high impedance.

B. Circuit Components

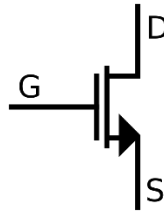
1. Transistor²

A transistor is a semiconductor device used to switch, detect, or amplify electronic signals and electrical power.

A transistor has at least three terminals for connection to an external circuit.

² Ex.-2024, ¶¶54-60.

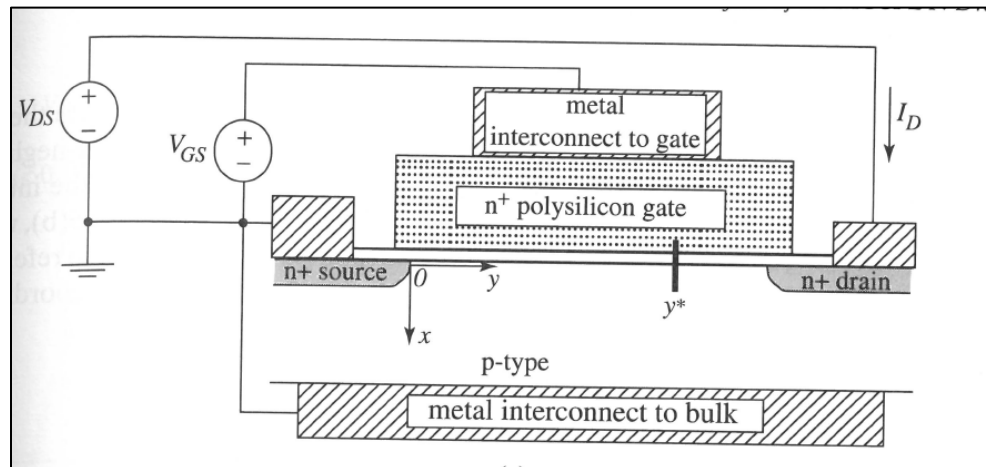
A field-effect transistor (FET) is one type of transistor. The symbol for one type of FET (below).



A FET has three terminals: (1) source (S), (2) drain (D), and (3) gate (G).

2. NMOS transistors³

An NMOS FET consists of three terminals: gate (G), drain (D), and source (S). The electron flow (current) from the drain (D) to the source (S) is controlled by the voltage at the gate (G).

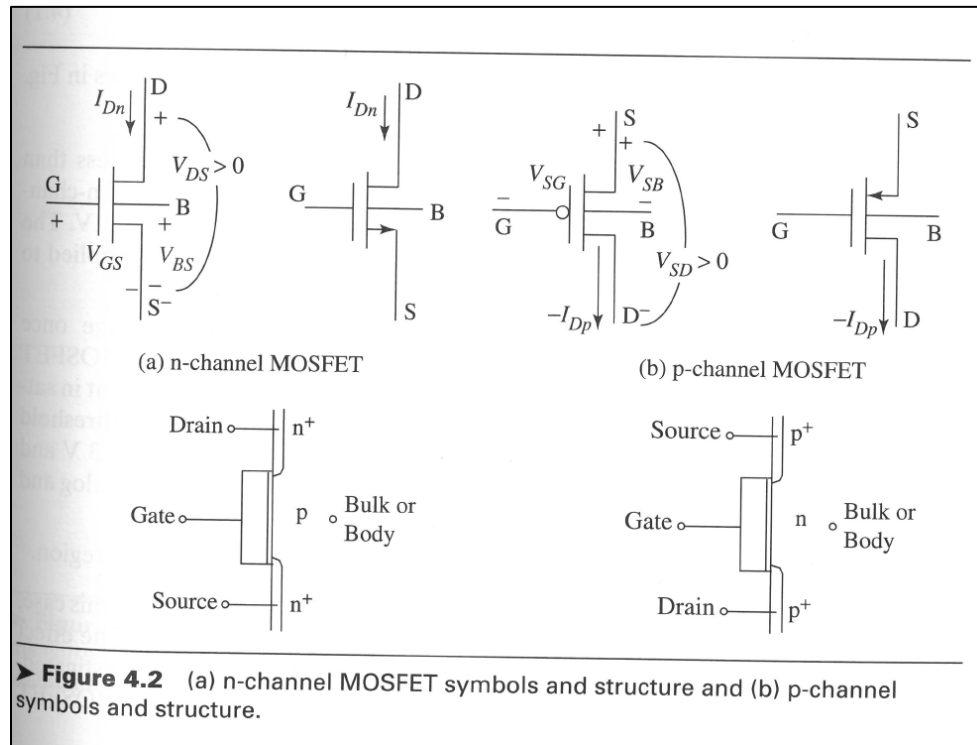


Ex.-2025, 199.

The symbol for a n-channel (and its dual the p-channel) MOSFET is shown

³ Ex.-2024, ¶¶61-68.

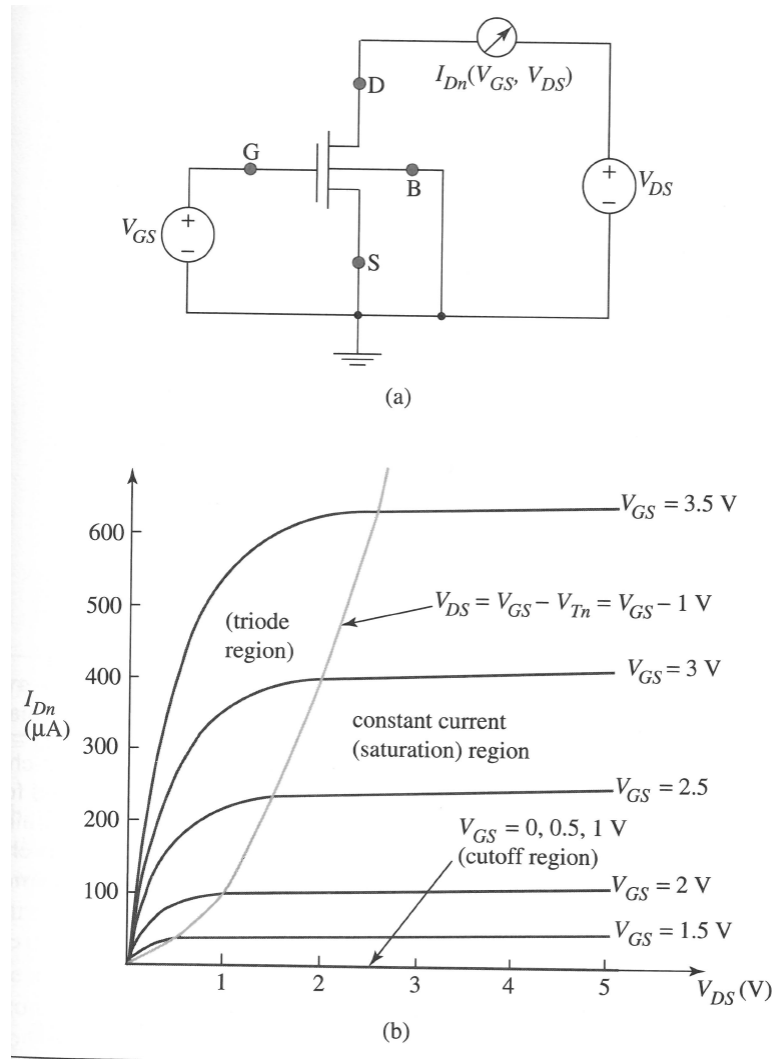
below.



Ex.-2025, 195.

As shown by the arrow in Figure 4.2 (a) above, the current I_{Dn} flows from the drain (D) to the source (S).

NMOS MOSFETs have two primary regions of operation: (1) triode region and (2) saturation region (shown below).



Ex.-2025, p. 197.

In saturation, the current flows only from the drain to the source (unidirectional).

3. Resistor

A resistor is a circuit element that introduces resistance into a circuit.

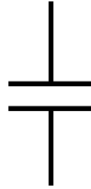
The symbol for one type of resistor is shown below. Ex.-2024, ¶¶69-71.



4. Capacitor

A capacitor is one type of circuit element used to store (accumulate) energy.

The symbol for one type of capacitor is shown below. Ex.-2024, ¶¶72-78.



5. Electrical Load⁴

An electrical load is an electrical element or portion of a circuit that absorbs power and converts it into a desired form. Whereas a power source supplies energy, a load extracts/uses energy. A resistor is a type of load.

Connecting a load to a capacitor affects the operation of the capacitor and, thus, the way the capacitor is used in a circuit. There are high impedance loads and low impedance loads. A high impedance load inhibits current from moving in a circuit and absorbs very little electrical energy. A low impedance load provides little constraint to current moving in a circuit and absorbs electrical energy. A low impedance load has low resistance. A high impedance load has high resistance.

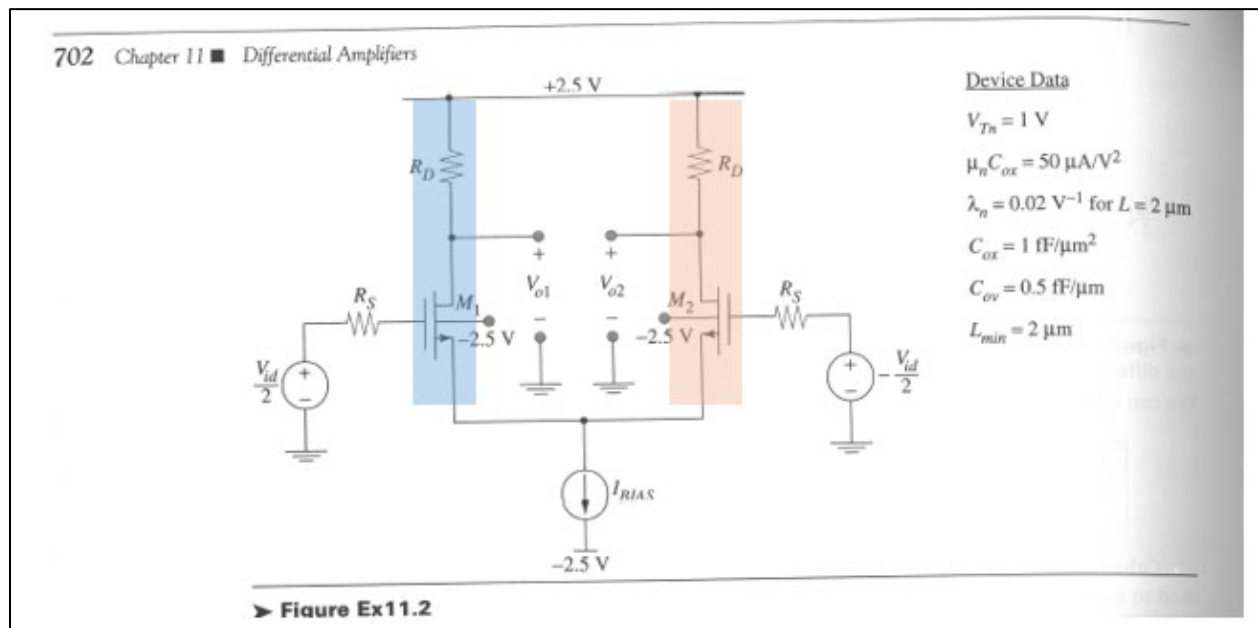
⁴ Ex.-2024, ¶¶79-81.

6. Local Oscillator

A local oscillator is “[a]n oscillator used in a ... circuit to reproduce a sum or difference frequency equal to the intermediate frequency of the receiver. This is done by mixing its output with the received signal.” Ex.-2031, p. 5. Ex.-2024, ¶¶82-86.

7. Differential Amplifiers⁵

A differential amplifier circuit amplifies a differential input signal using a “differential pair,” which consists of a pair of transistors (see below).



Ex.-2025, 702.

The differential amplifier circuit operates with a constant current bias, which provides the bias, or operating point (quiescent point), for both transistors M1 and

⁵ Ex.-2024, ¶¶87-93.

M2. A differential input voltage which is split into its differential components (positive/negative component) is applied to the gates of M1 and M2.

The bias current I_{BIAS} is divided between: (i) transistor M1 and resistor R_D (blue) and (ii) transistor M2 and resistor R_D (red). The differential output voltage is composed of V_{o1} and V_{o2} .

The differential input voltage (V_{id}) steers the current I_{BIAS} between the two branches (blue, red).

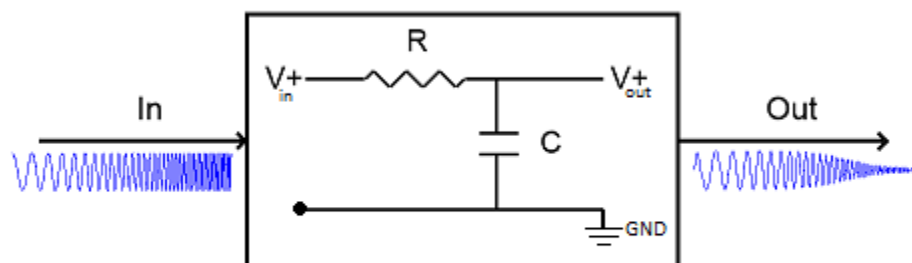
Operational amplifiers (op-amps) use a differential pair as their input.

Ex.-2025, 709.

Op-amp input impedance is extremely high.

8. Low-pass Filter

A low pass filter is a circuit that attenuates high-frequency signals while allowing low-frequency signals to pass through. Typically, a low-pass filter shunts high-frequency components to ground.

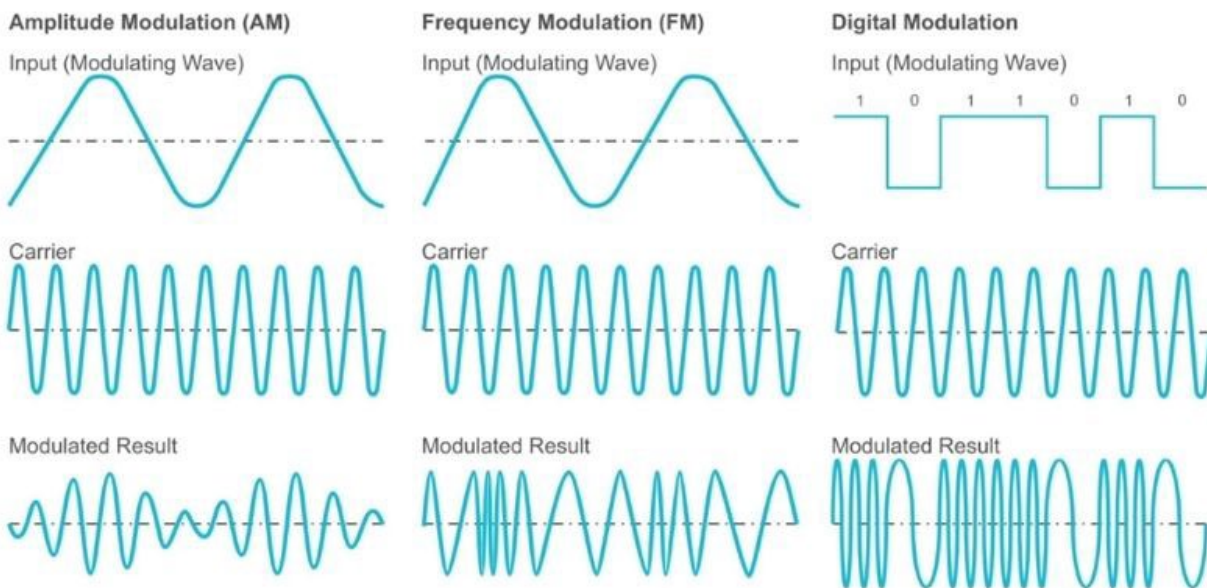


Transfer Function:
$$T(j\omega) = \frac{\text{Out}}{\text{In}} = \frac{1}{1 + j\omega CR}$$

A low-pass filter can be implemented in various ways. In the simple RC filter above, filtering is achieved due to the frequency-dependent impedance of the capacitor, C. Ex.-2024, ¶¶94-95.⁶

9. Carrier Synchronization

In RF systems, a transmitted signal is upconverted by modulating a carrier. Modulation schemes are shown below.



In order to properly receive the entire range of modulations, a receiver must maintain a synchronized local oscillator (LO) to the carrier frequency.

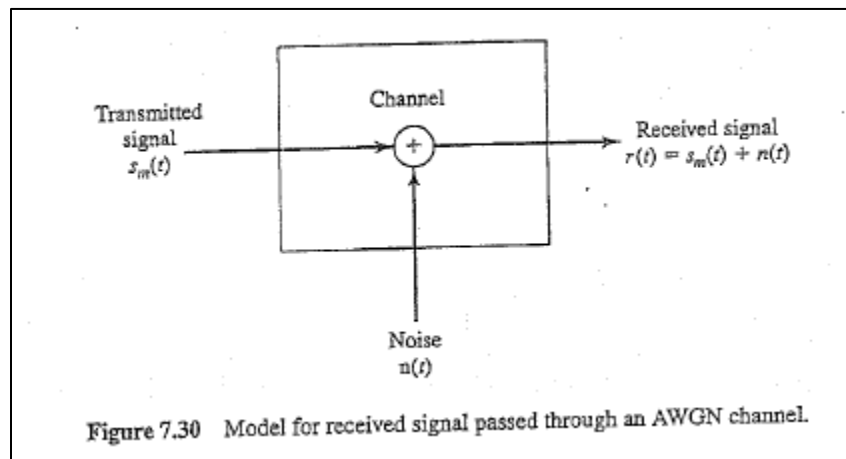
Using a synchronized carrier for down-conversion is known as coherent down-conversion, because the local oscillator is phase-locked to the received signal.

⁶ Ex.-2024, ¶¶96-99.

10. Matched Filter/Correlator⁷

In digital signal processing, filtering is used to achieve optimal detection of a signal (lowest probability of detection error). A matched filter or correlator-based demodulator can be used for such optimal detection. Ex.-2017, 381.

A matched filter or correlator is a method used to optimize signal detection after the signal has been received by an RF system. There exists a specific filter transfer function that minimizes the probability of detection error for a signal that has been subjected to additive noise, i.e. received signal $s(t)$ plus noise $n(t)$.



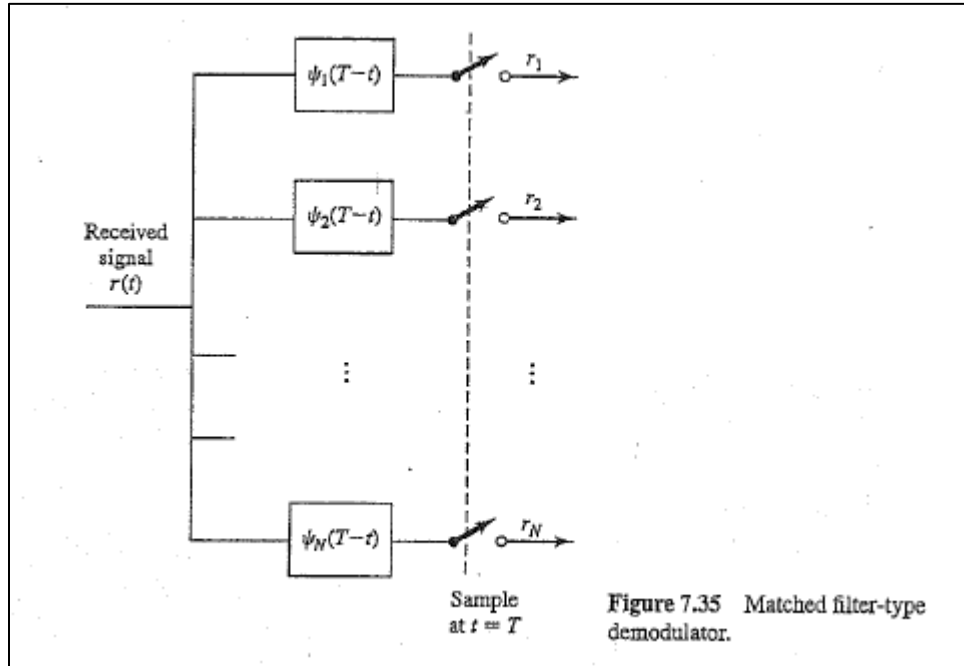
Id., 370, 378.

The optimal filter is “matched” or directly related to the input signal (without noise), $s(t)$.

Because matched filters in communication systems are used for signal detection, conversion from the analog domain to digital domain is often required.

⁷ Ex.-2024, ¶¶100-105.

This is done by sampling the analog signal and detecting the signal at that time.



Id., 377.

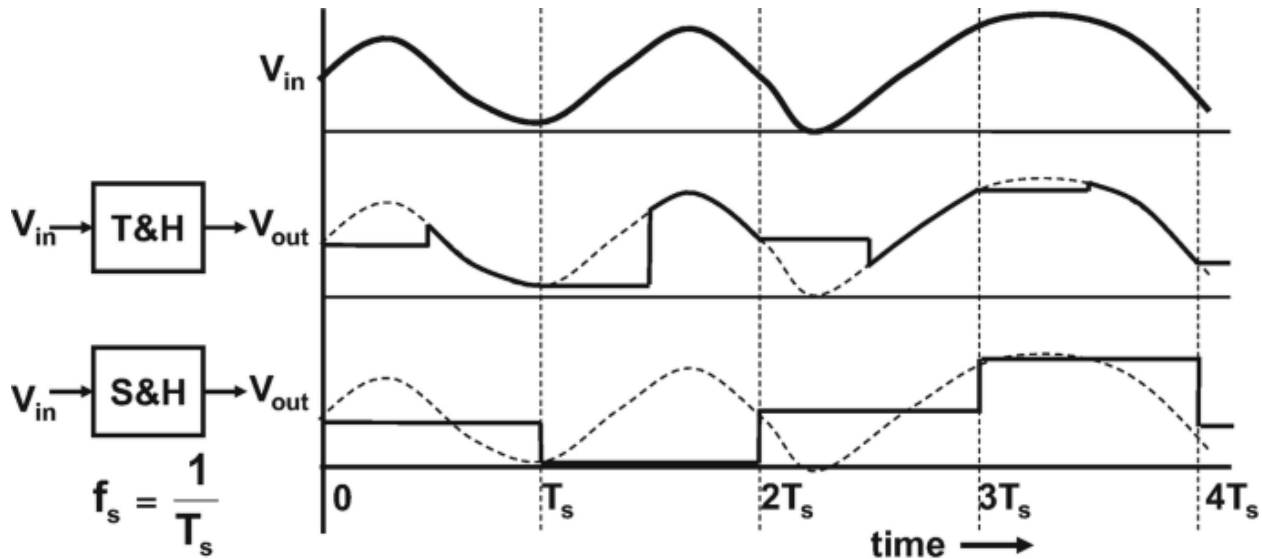
The '177 patent applies the concept of a matched filter/correlator in a different way than traditional signal processing. The '177 patent realizes that an RF sampling system itself can be designed to function both as a down-conversion circuit and as an optimal filter for maximizing SNR.

11.Sampling⁸

Sampling is the process of taking a continuous time signal and converting it to a discrete time signal. There are two common, traditional voltage sampling techniques: (1) sample-and-hold, where a sample at a time instance is taken and that

⁸ Ex.-2024, ¶¶106-107.

value is held for a period of time, and (2) track-and-hold, where the signal is tracked and then at time T , it is held at that value. This produces a discrete representation of the analog signal. The diagram below shows the two types of sampling



IV. SAMPLING SYSTEMS

Sampling-based down-conversion uses switches to capture discrete samples of the RF signal at specific time intervals.

Sampling-based down-conversion systems can be categorized into: (1) energy transfer (energy sampling) systems, and (2) voltage sampling systems. Ex.-2024,¶¶122-123.

A. Voltage sampling

In the late 1980s through 2000, a technology being considered for direct down-conversion was sample-and-hold (voltage sampling). Ex.-2024,¶¶124-125.

One implementation of sample-and-hold was based on sampling the RF signal using an impulse sampling concept. Another implementation of sample-and-hold is track-and-hold. Ex.-2024, ¶¶126-127.

In a voltage sampling system, the system captures discrete voltage readings on a capacitor and recreates the baseband signal based on those voltage readings. A high impedance load is used to hold the voltage on a capacitor during each sample. The high impedance load prevents the capacitor from discharging so that an accurate reading of voltage can be taken. Without a high impedance load, the voltage on the capacitor would fluctuate, thereby preventing an accurate reading of the voltage. Without an accurate reading of the voltage, the baseband signal cannot be accurately recreated (the system would not work). Each sample of a voltage sampling circuit is independent from the previous sample. Energy does not become part of the baseband signal; instead, energy is effectively thrown away and wasted. Ex.-2024, ¶128.

B. Energy Sampling

Energy transfer (energy sampling) was/is a fundamentally different and competing method to voltage sampling. Energy samplers do not attempt to replicate or sample the voltage of an RF signal. Thus, at the time of the invention of the '177 patent, a POSITA would not substitute an energy transfer system in place of a sample-and-hold/voltage sampling system and vice versa. Ex.-2024, ¶¶129-130.

In ParkerVision's energy transfer system, non-negligible amounts of energy from an input signal (a radio frequency (RF) signal) pass through the switch and form the down-converted (baseband) signal, i.e., the sampled energy from the input signal makes up/becomes part of the baseband signal itself. In an energy transfer system, energy is integrated on a storage module over multiple samples and a low impedance load is used. This configuration allows energy to continuously flow to the low impedance load and form the baseband signal. In particular, the RF signal drives the low impedance load when the switch is closed (ON), and the storage module continues to drive the low impedance load when the switch is opened (OFF). So energy flows from the switch when the switch is closed (ON) and from the storage module when the switch is opened (OFF). Ex.-2024,¶131.

If the capacitor did not continue to drive the low impedance load, the system would not work properly, and information would be lost. Ex.-2024,¶¶132-134.

Energy sampling is an accurate way to form a baseband signal. What ParkerVision realized, and others did not, was that accurately capturing the voltage of the RF signal was not critical. ParkerVision realized that using most or all of the available energy was the best way to form the baseband signal. An advantage of energy sampling system is that the energy stored on the capacitor is accumulated over multiple cycles of the RF signal. Moreover, the baseband signal carries

significant power because non-negligible energy is discharged from the capacitor for driving a low impedance load. Ex.-2024,¶¶135-136.

V. U.S. PATENT No. 7,865,177

A. Overview

The '177 patent discloses a system and method for down-converting an electromagnetic signal. Ex.-2024,¶137.

The '177 patent uses a matched filtering/correlating module to perform down-conversion. In particular, the '177 patent discloses “down-convert[ing] an electromagnetic signal by repeatedly performing a matched filtering or correlating operations on a received carrier signal.” TI-1001, 130:23-25. The '177 patent discloses that the result of each “matched filtering/correlating process” is “accumulated, for example using a capacitive storage device” and “used to form a down-converted version of the electromagnetic signal.” Id., 130:28-31. Ex.-2024,¶138.

The “matched filtering/correlating process or processor produces enhanced ... signal-to-noise ratio[] (SNR) for the processed waveform. Id., 130:34-37. The matched filtering/correlating process “preserves the energy of the electromagnetic signal and transfers it through the processor.” Id., 130:37-39. Ex.-2024,¶139.

The '177 patent explains that “*the present invention* operates by accumulating the energy of a carrier signal and using the accumulated energy to produce the same

or substantially the same result that would be obtained by an ideal impulse sampler.”⁹ Id., 130:54-58. The '177 patent notes that “[t]he quality of the down-converted electromagnetic signal is a function of how efficiently the various embodiments of the present invention are able to accumulate the energy” Id., 130:63-67.

The '177 patent recognizes that the implementation of matched filtering/correlating is new. In particular, the patent states “*the present invention is not a traditional realization of a matched filter/correlator.*” Id., 132:15-17. Ex.-2024,¶141.

The '177 patent explains how to implement the claimed matched filtering/correlating module. Id., 130:40-48; see e.g., Figures 72, 148-154, 171-177A, 182, 184, 193 (and associated text). Ex.-2024,¶142.

B. The patent disclosure regarding down-conversion systems

U.S. Patent No. 6,061,551 (“the '551 patent”) (Ex.-2033) is incorporated by reference into the '177 patent.

The '177 patent discloses two systems for down-conversion: (1) energy transfer (energy sampling) and (2) sample-and-hold (voltage sampling). Ex.-2024,¶145.

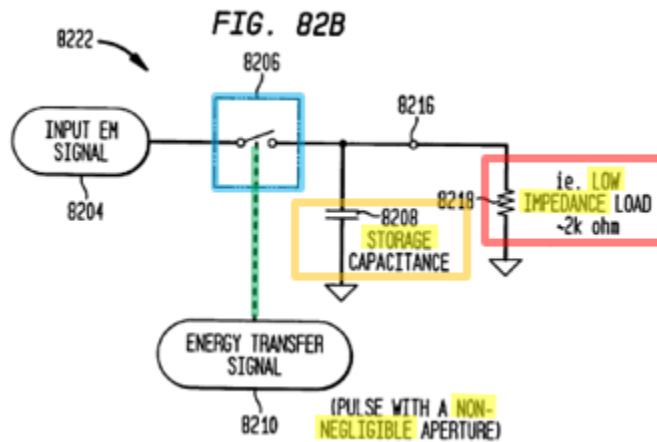
⁹ Unless otherwise noted, all emphasis has been added.

The claims of the '177 patent are directed to an energy transfer system. See Section VI.A. Ex.-2024, ¶146.

Energy transfer and sample/hold are distinctly different technologies. Ex.1001, 73:5-74:52 (energy transfer system); 60:61-62:4 (sample/hold system). While energy transfer and sample/hold both result in down-converted signals, an energy transfer system had numerous advantages. *Id.*, 69:34-37, 73:5-25. Ex.-2024, ¶147.

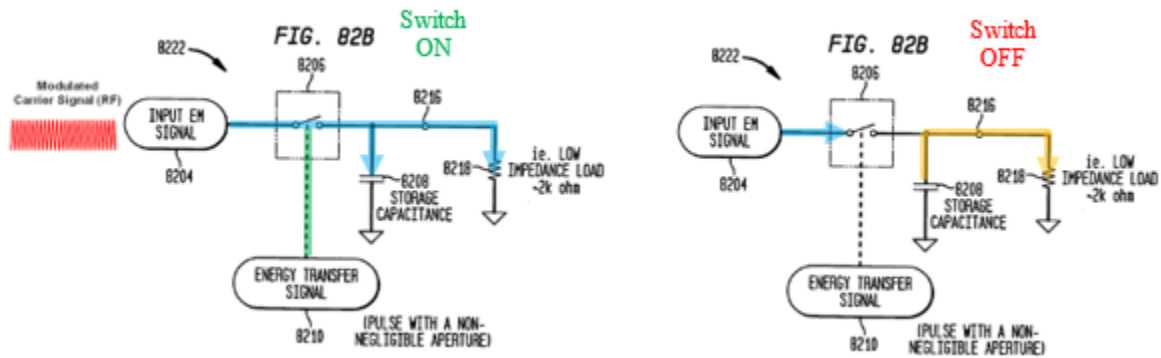
1. Energy Transfer (energy sampling)¹⁰

Figure 82B of the '177 patent (below) illustrates an energy transfer system, which would be incorporated into a transceiver chip of a wireless device.

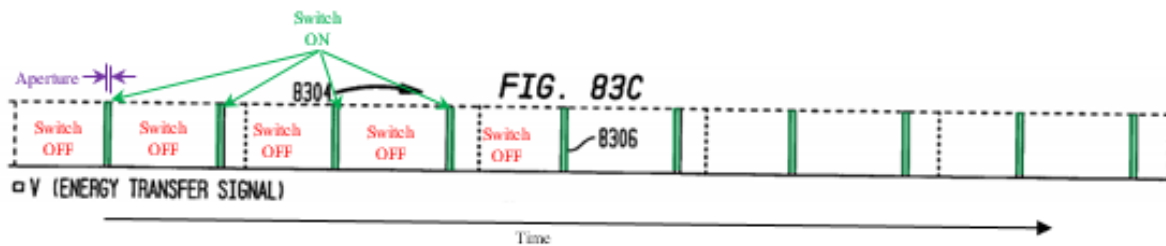


¹⁰ Ex.-2024, ¶¶148-156.

The system includes a switch 8206 (blue), an energy transfer signal 8210 (green) for controlling the switch, a “storage” capacitor A low impedance is what enables a storage capacitor to discharge its energy when the switch is OFF (open).



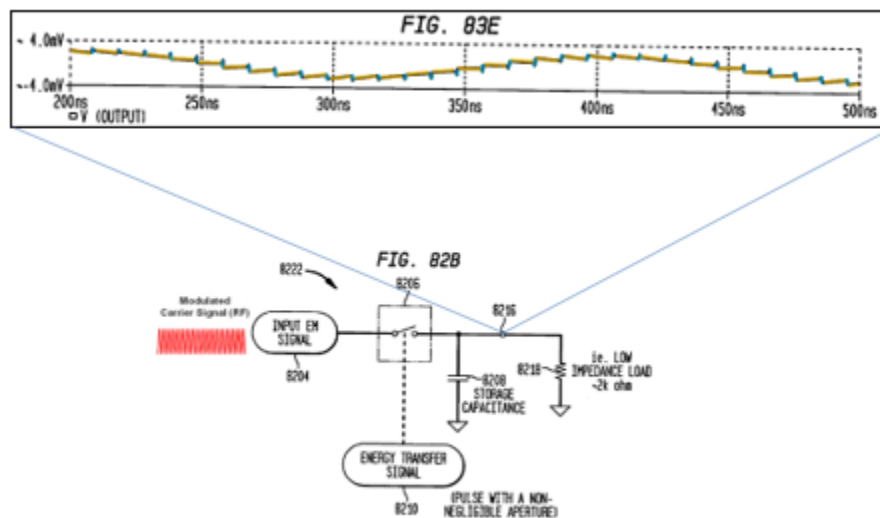
The annotations in Figure 82B above illustrate how an energy transfer system down-converts a high frequency input EM signal 8204 (e.g., modulated carrier signal (red)) to a baseband signal. In particular, down-conversion occurs by repetitively opening and closing the switch 8206.



As shown in Figure 83C above, the switch is turned ON (closed) by sending a pulse 8306 (green) to the switch. The switch is kept ON (kept closed) for the duration of the pulse (i.e., a non-negligible aperture (purple) of the pulse). As shown

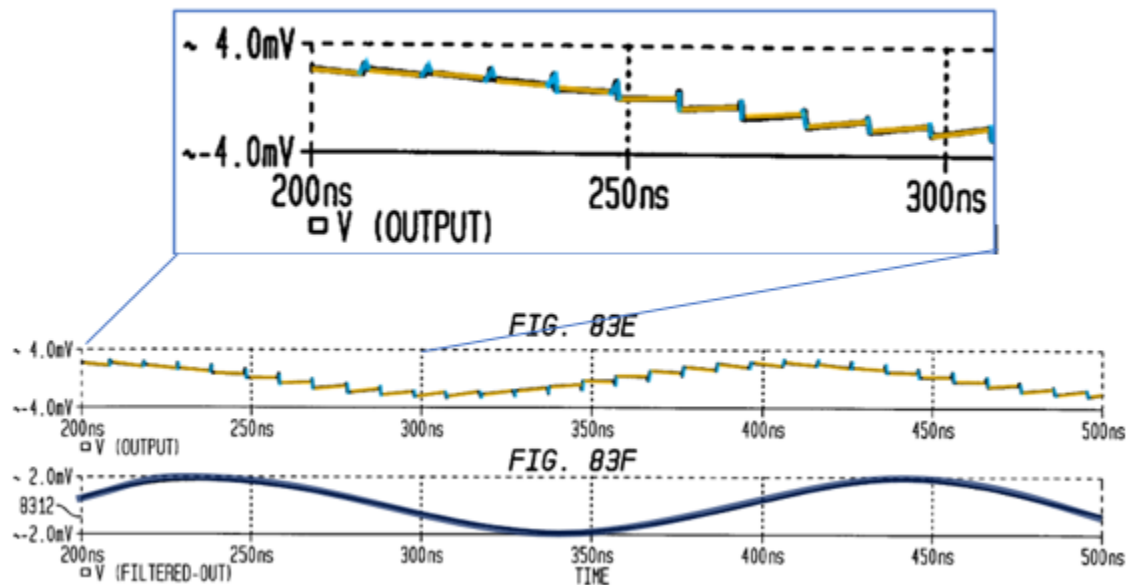
by the repetitive pulses 8306, this opening and closing of the switch repeats continuously over time.

As shown in Figure 82B above (left), when the switch is ON (during the aperture), a portion of the input EM signal 8204 (blue) passes to the “storage” capacitor 8208 and the low impedance load 8218. When the pulse 8306 (green) stops, the switch is turned OFF (opened), and the input EM signal is prevented from passing through the switch. Since the load is low impedance, when the switch is OFF (opened), as shown in Figure 82B above (right), energy (orange) stored in the “storage” capacitor 8208 is discharged to the low impedance load 8218.



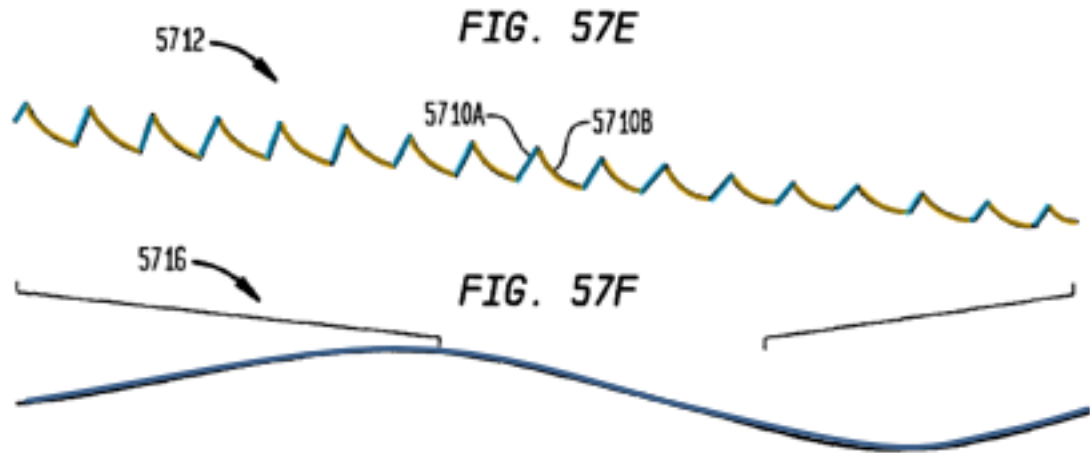
The repetitive opening and closing of the switch results in the waveform (blue/orange) shown above in Figure 83E at terminal 8216. The waveform is made

up of energy (blue) from the EM signal and discharged energy (orange) from the “storage” capacitor.



As shown above, the waveform of Figure 83E is filtered to create a smooth waveform (dark blue) as shown in Figure 83F.

The figures below illustrate a close-up view of another embodiment of a down-converted signal in an energy transfer system.

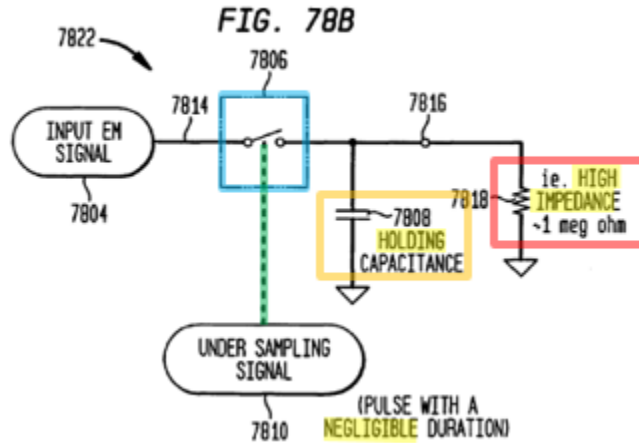


The baseband signal is derived from an accumulation function (e.g., integration) in which the energy transferred from the current cycle is combined with previously accumulated energy left in the storage module from preceding cycles. Energy transfer occurs and is accumulated, or “integrated,” over multiple apertures.

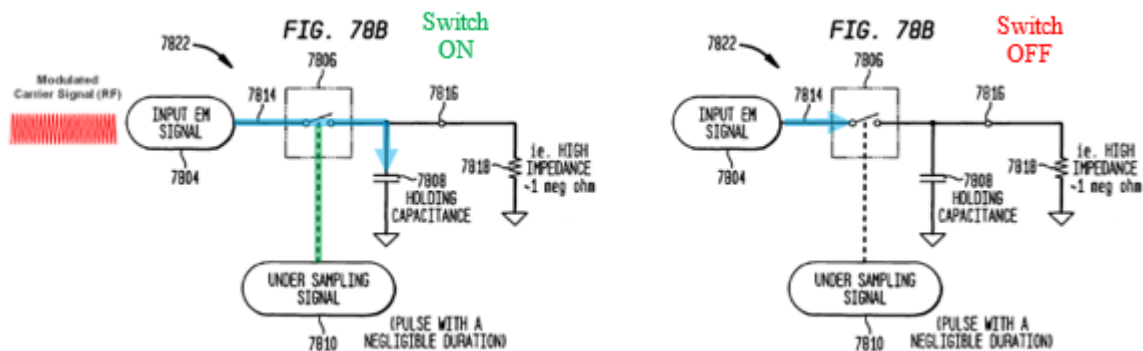
2. Sample-and-hold (voltage sampling)¹¹

Figure 78B of the '177 patent illustrates a voltage sampling system.

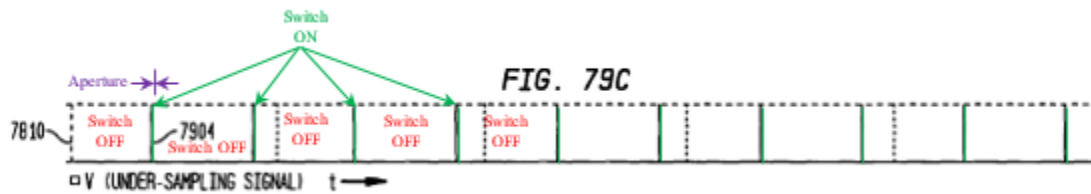
¹¹ Ex.-2024, ¶¶157-164.



The system includes a switch 7806 (blue), a control signal 7810 (green) for controlling the switch, a “holding” capacitor 7808 (orange) for holding a voltage across the capacitor, and a high impedance load (red). A high impedance load is specifically included to prevent the holding capacitor from discharging energy.



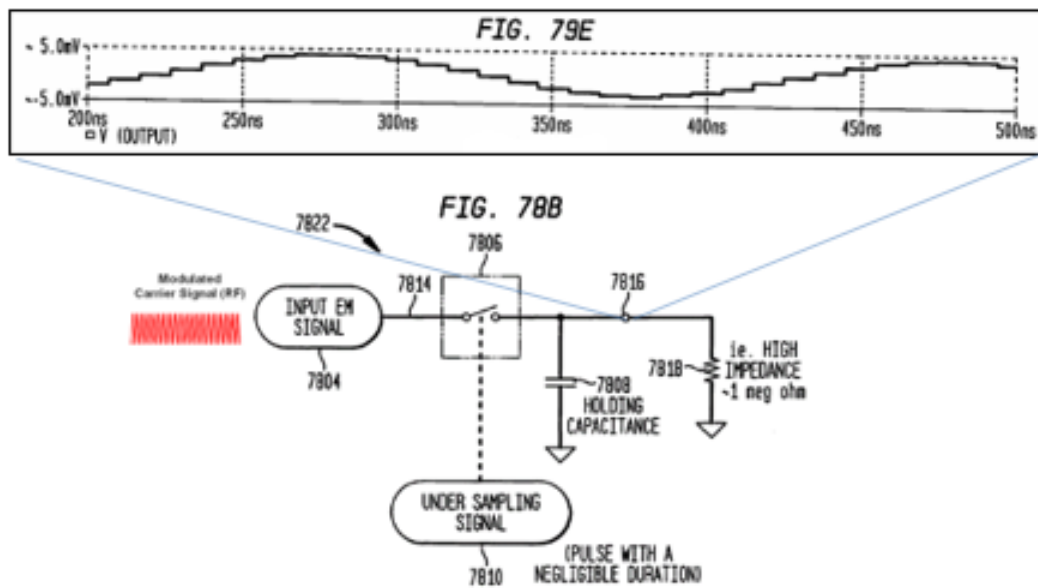
The annotations in Figure 78B illustrate how a sample and hold system down-converts a high frequency input EM signal 7804 (e.g., modulated carrier signal (red)) to a baseband signal.



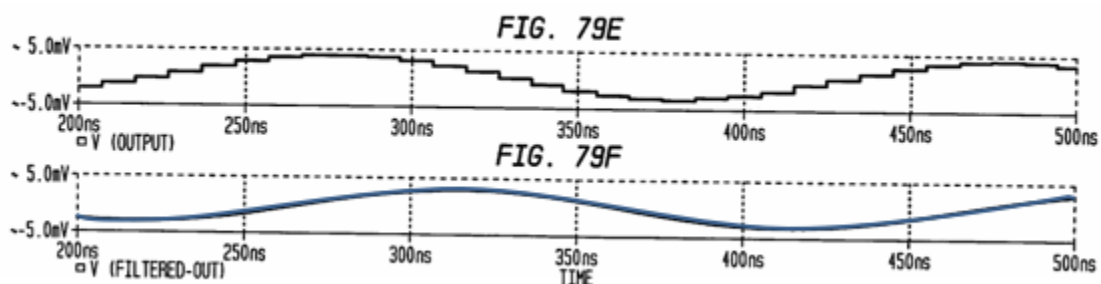
As shown in Figure 79C, the switch is turned ON (closed) by sending a pulse 7904 (green vertical line) of an extremely short/negligible duration to the switch. Thus, the aperture (purple) of a pulse is referred to as a negligible aperture because the pulse width “tend[s] toward zero time.” Ex.-1001, 70:19-21. As shown by the repetitive pulses 7904, this opening and closing of the switch repeats continuously over time.

As shown in Figure 78B above, when the switch is ON (closed) (during the aperture), the EM signal 8204 (blue) is sent to the “holding” capacitor 7808. When the pulse 7904 (green) stops, the switch is turned OFF (opened). Because sample and hold uses a high impedance load, when the switch is OFF (opened), there is high resistance to the flow of current.

Because there is no significant energy discharge between pulses, the terminal 7816 maintains a constant voltage value until the next pulse. *Id.* at 64:21-26. The voltage value serves as the “sample” of a discrete voltage value that the system uses to recover the baseband signal.

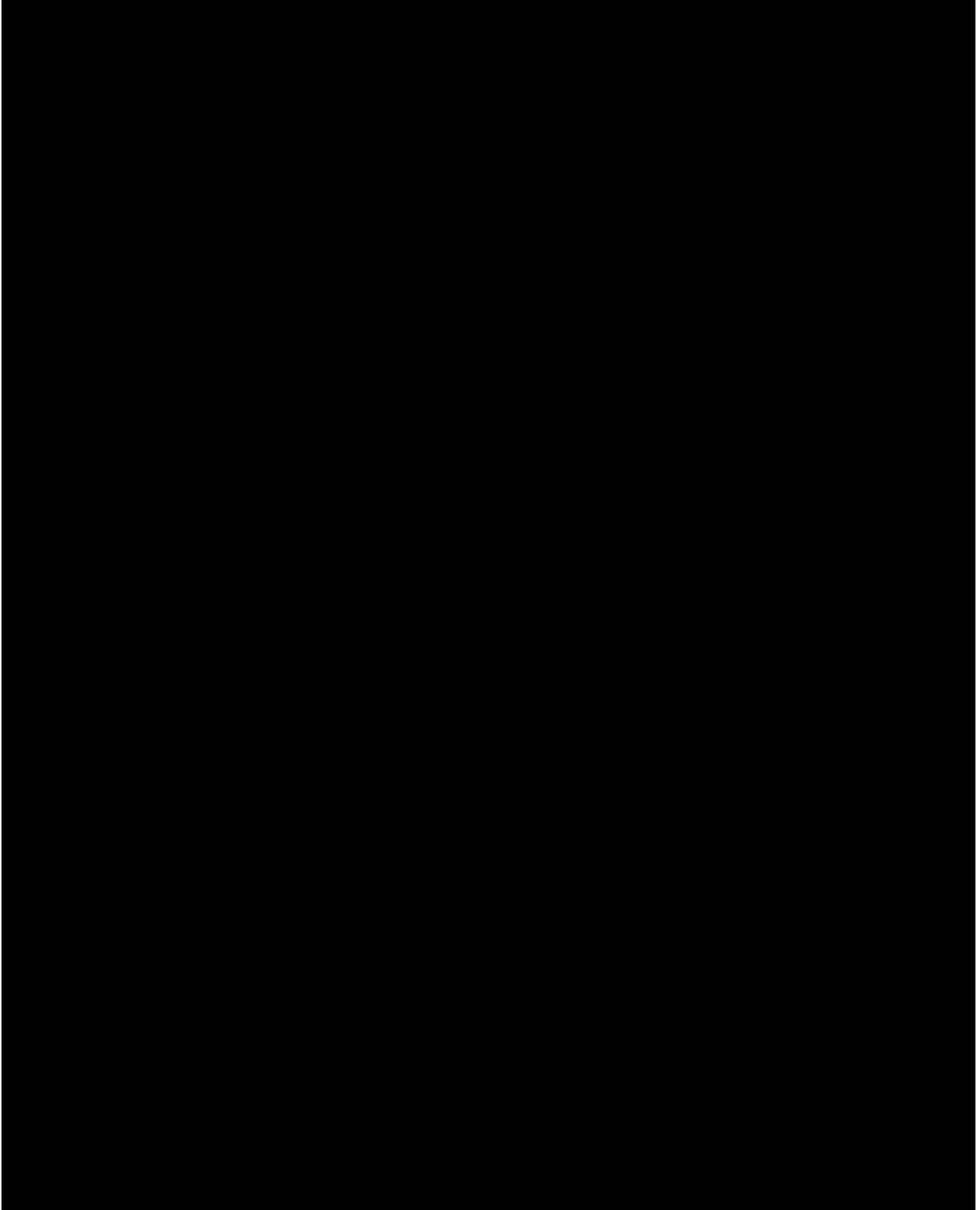


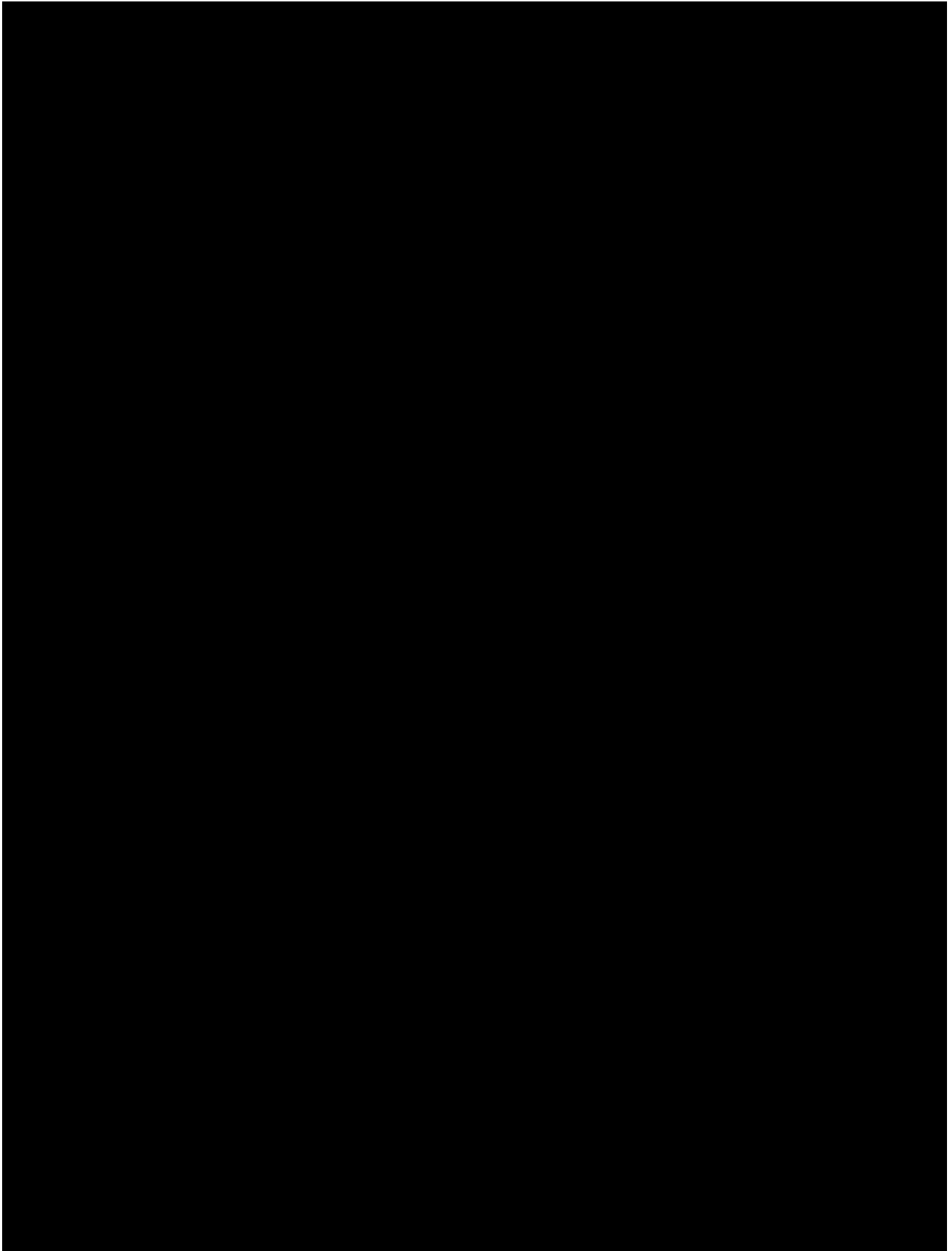
As shown in Figure 79E, sample and hold produces a voltage wave with a stair step pattern. The vertical part of the step represents the “sample” of the voltage value which occurs at the time of pulse 7904. The horizontal portion of the step represents the “holding” of that voltage value until the next pulse when the next sample of voltage is taken. *Id.* at 64:26-30.

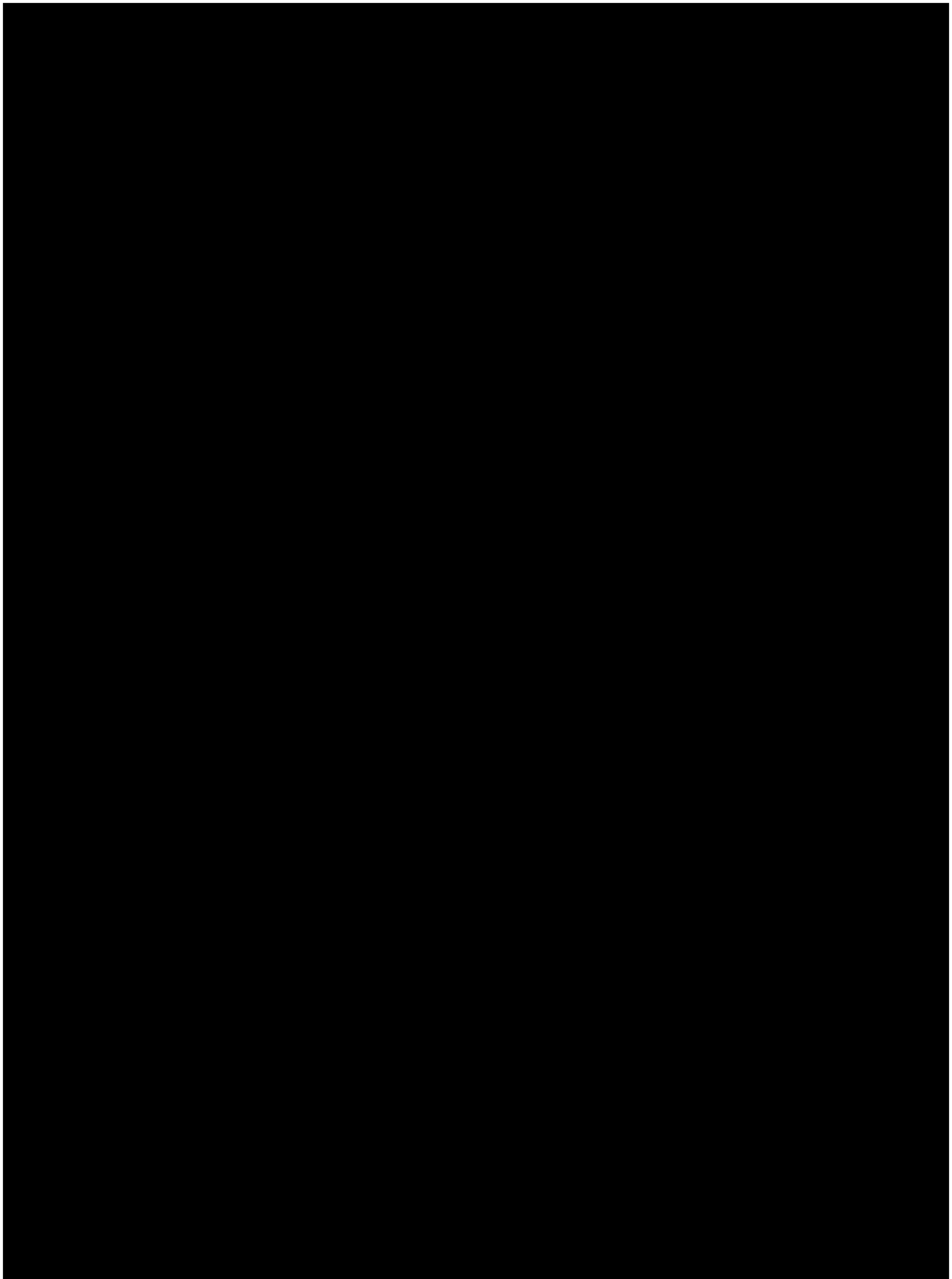


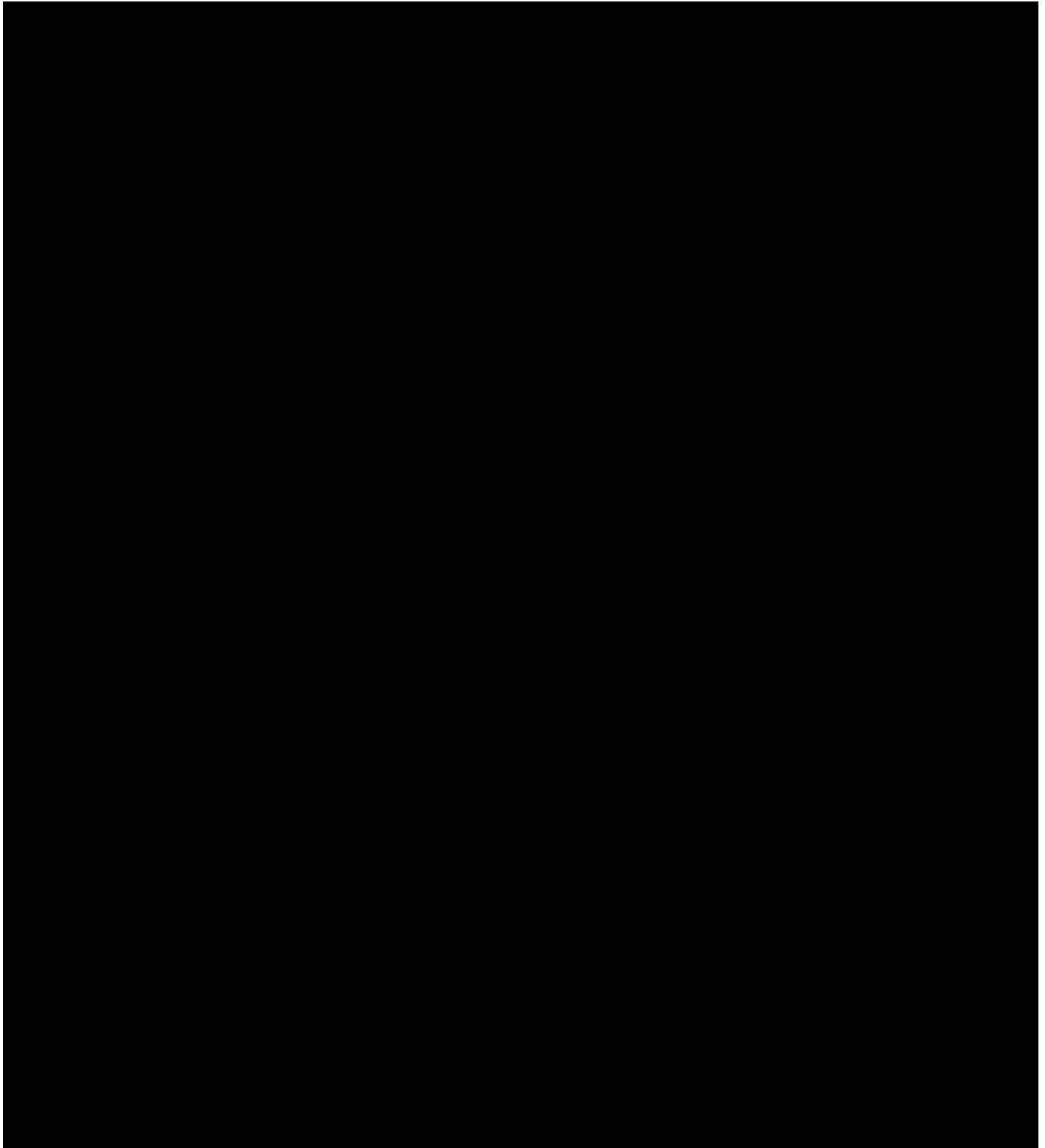
As shown above, the waveform of Figure 79E is filtered to create a smooth waveform (dark blue) as shown in Figure 79F.

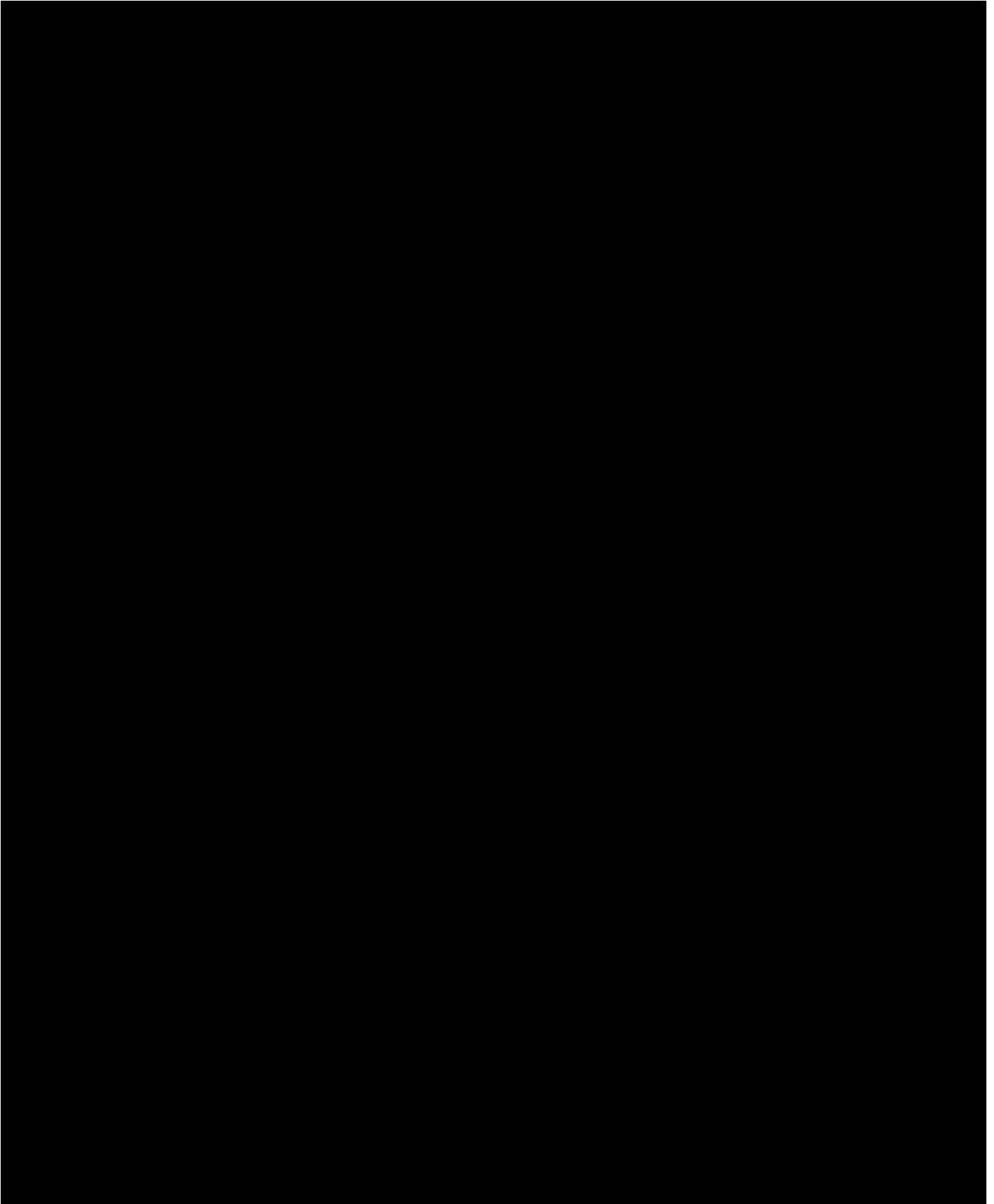
C. Conception and Reduction to Practice

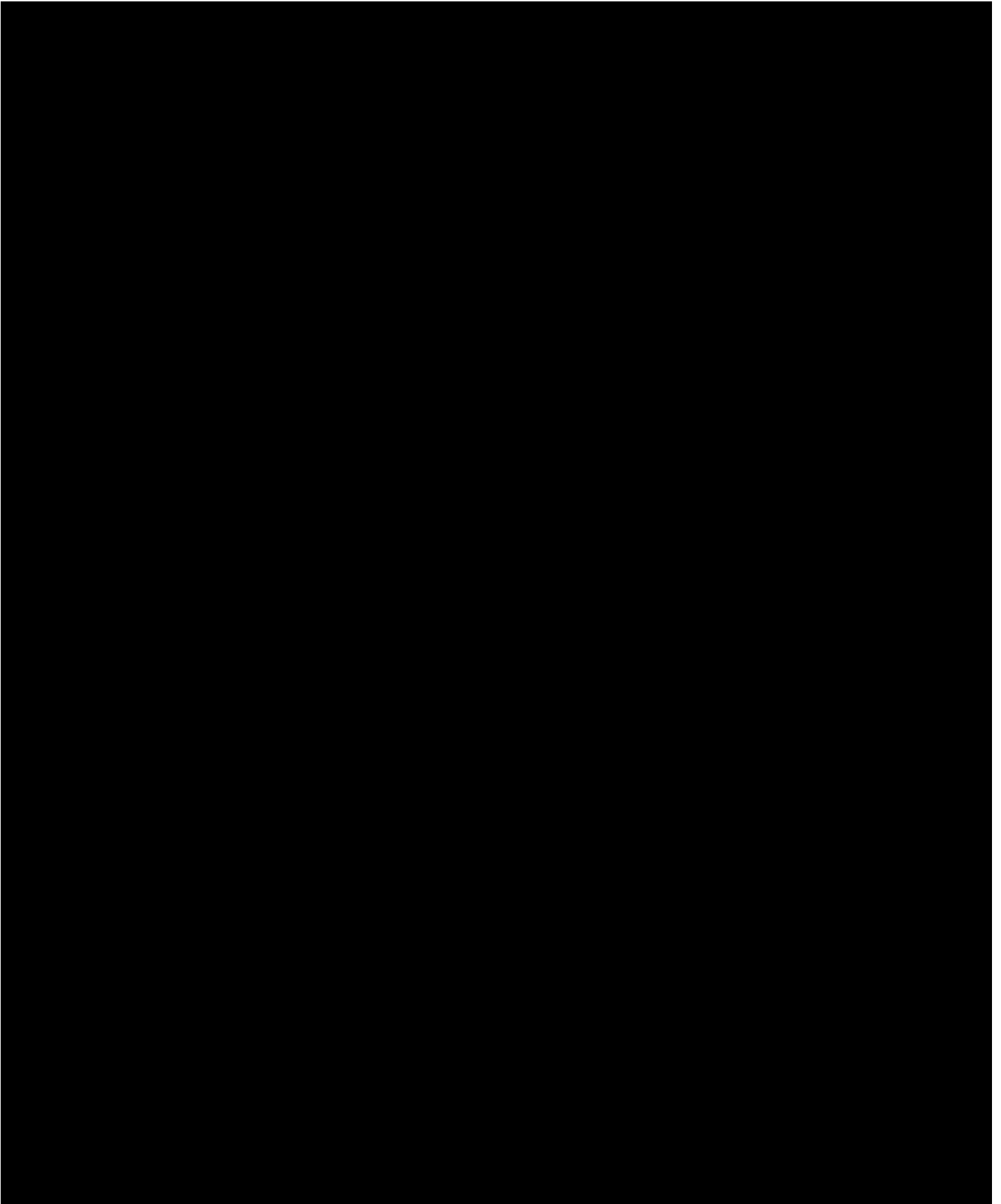


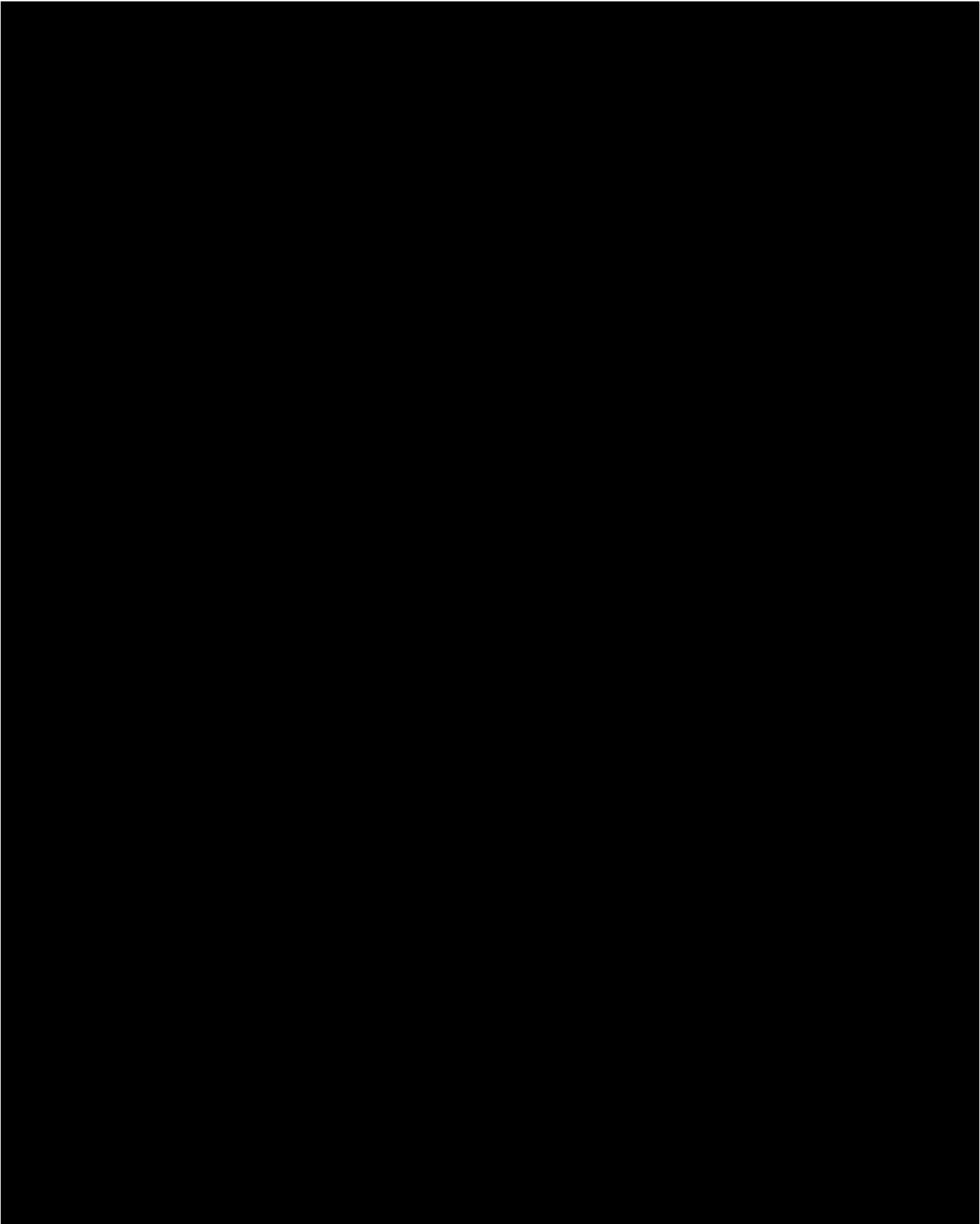


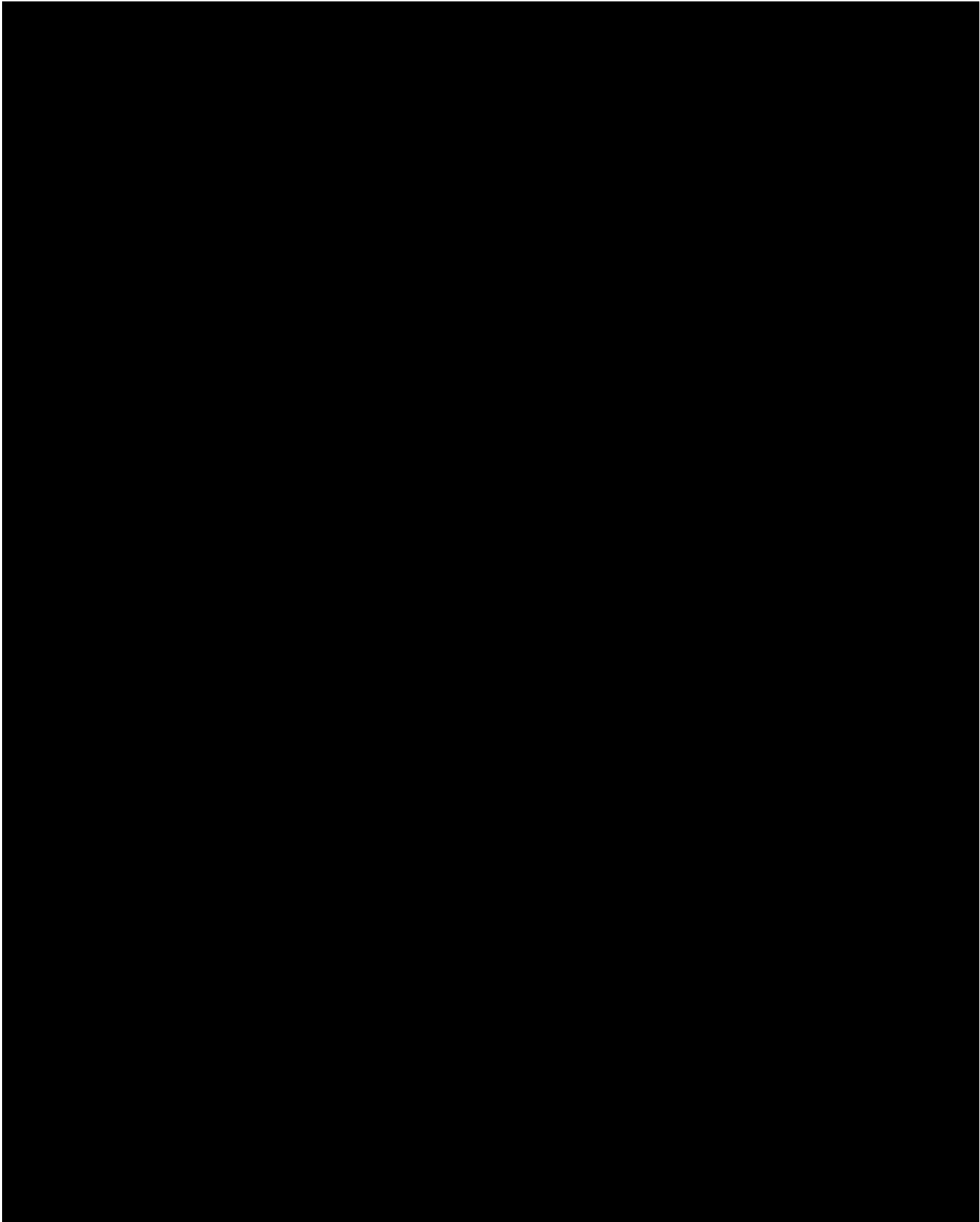


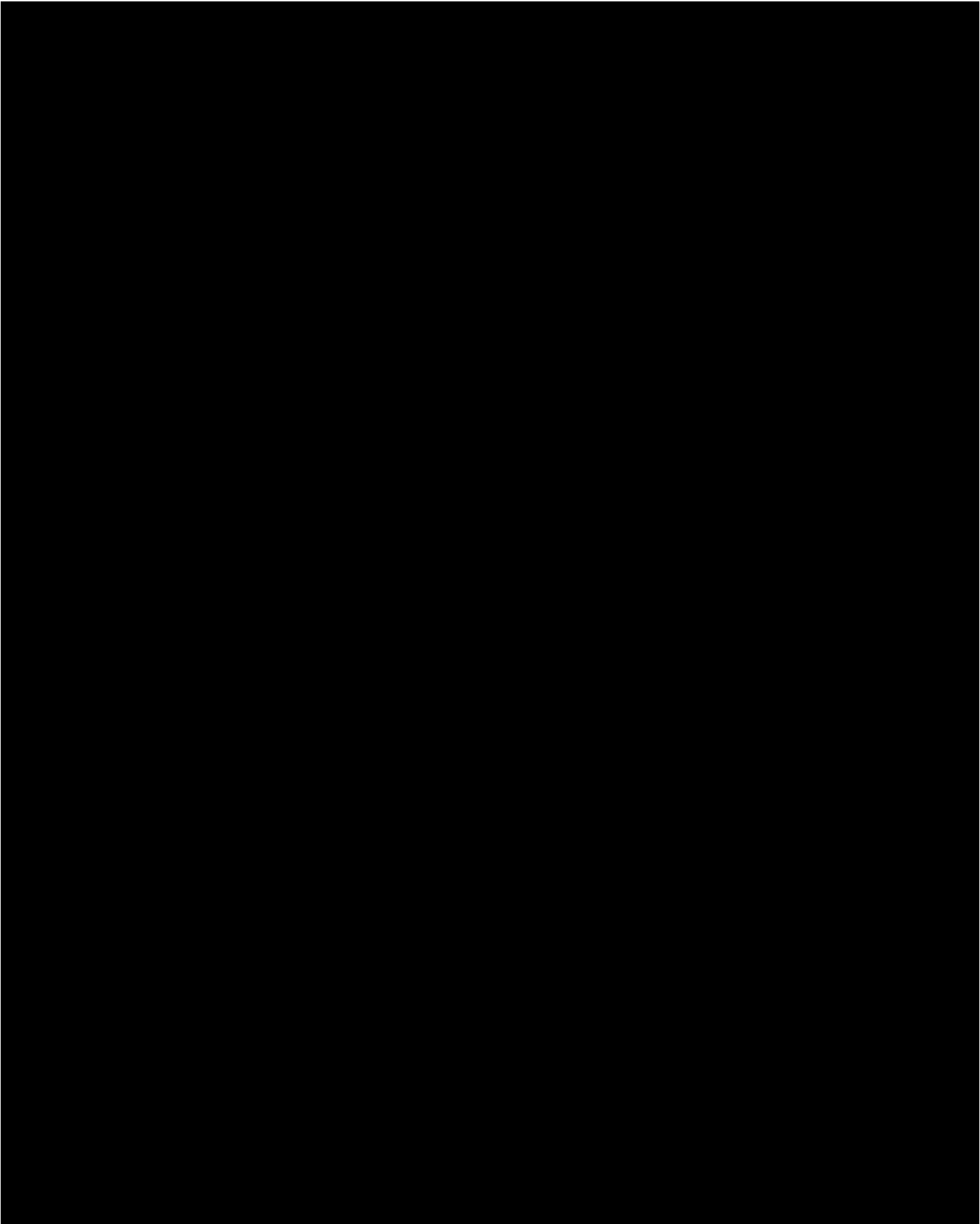


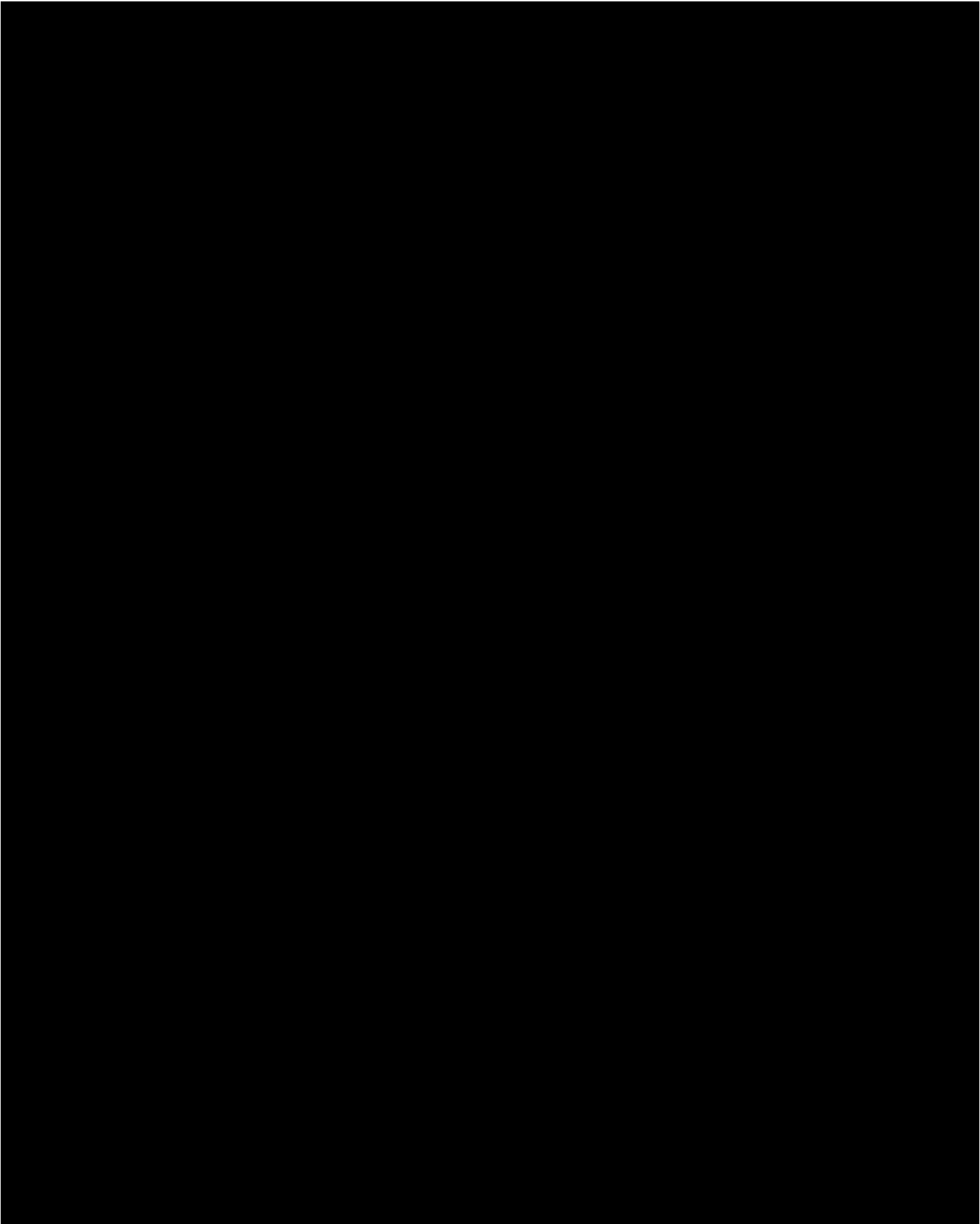


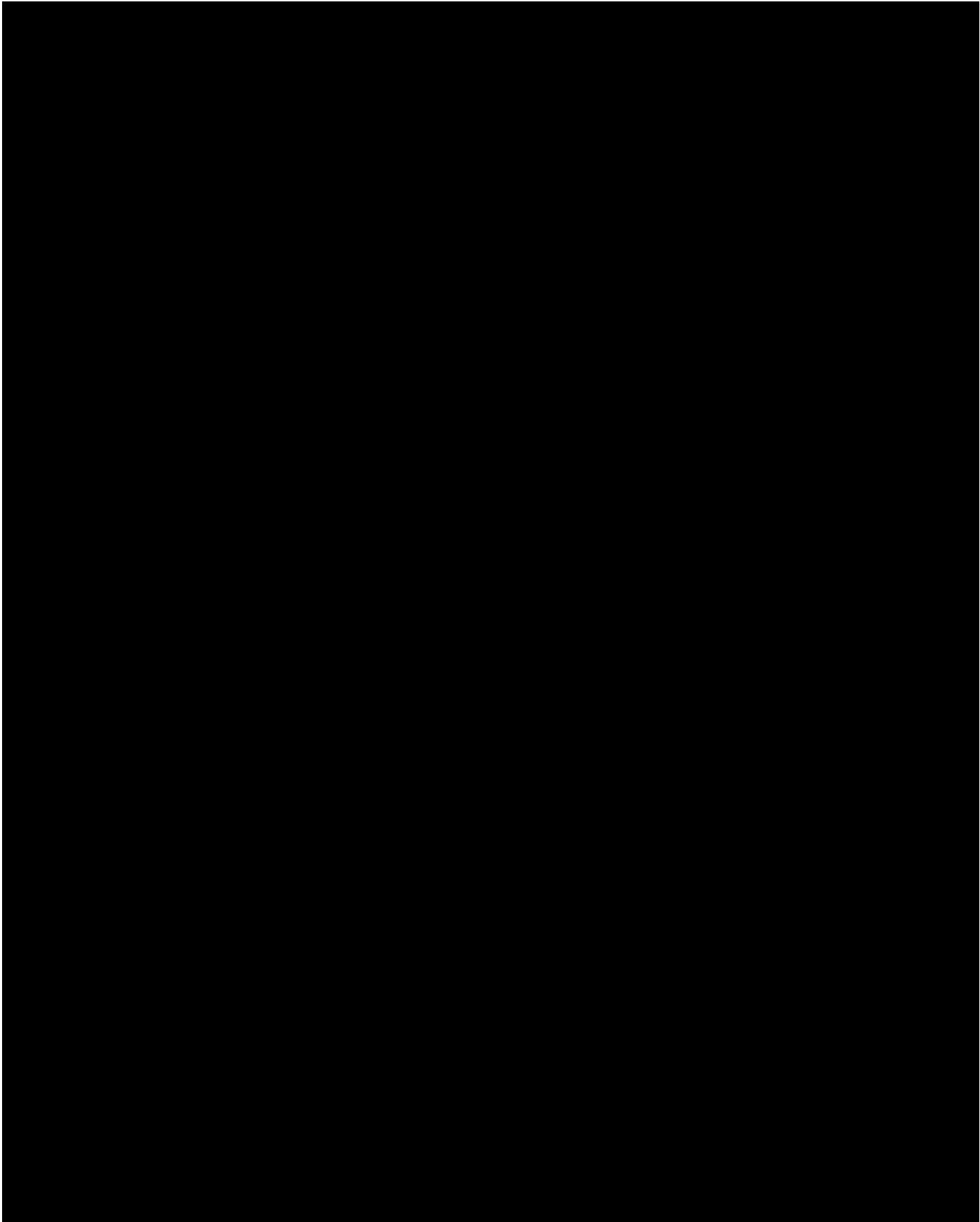


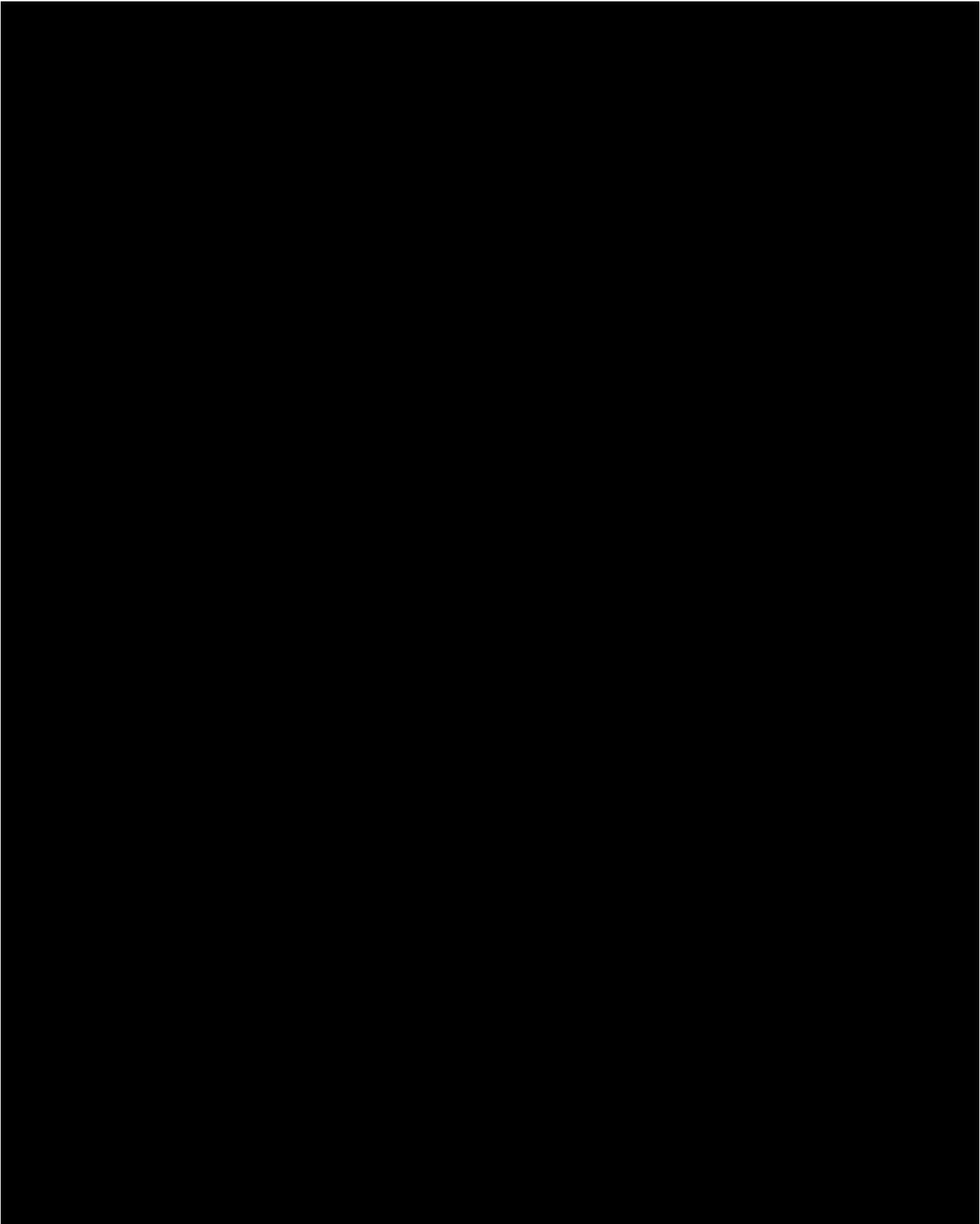


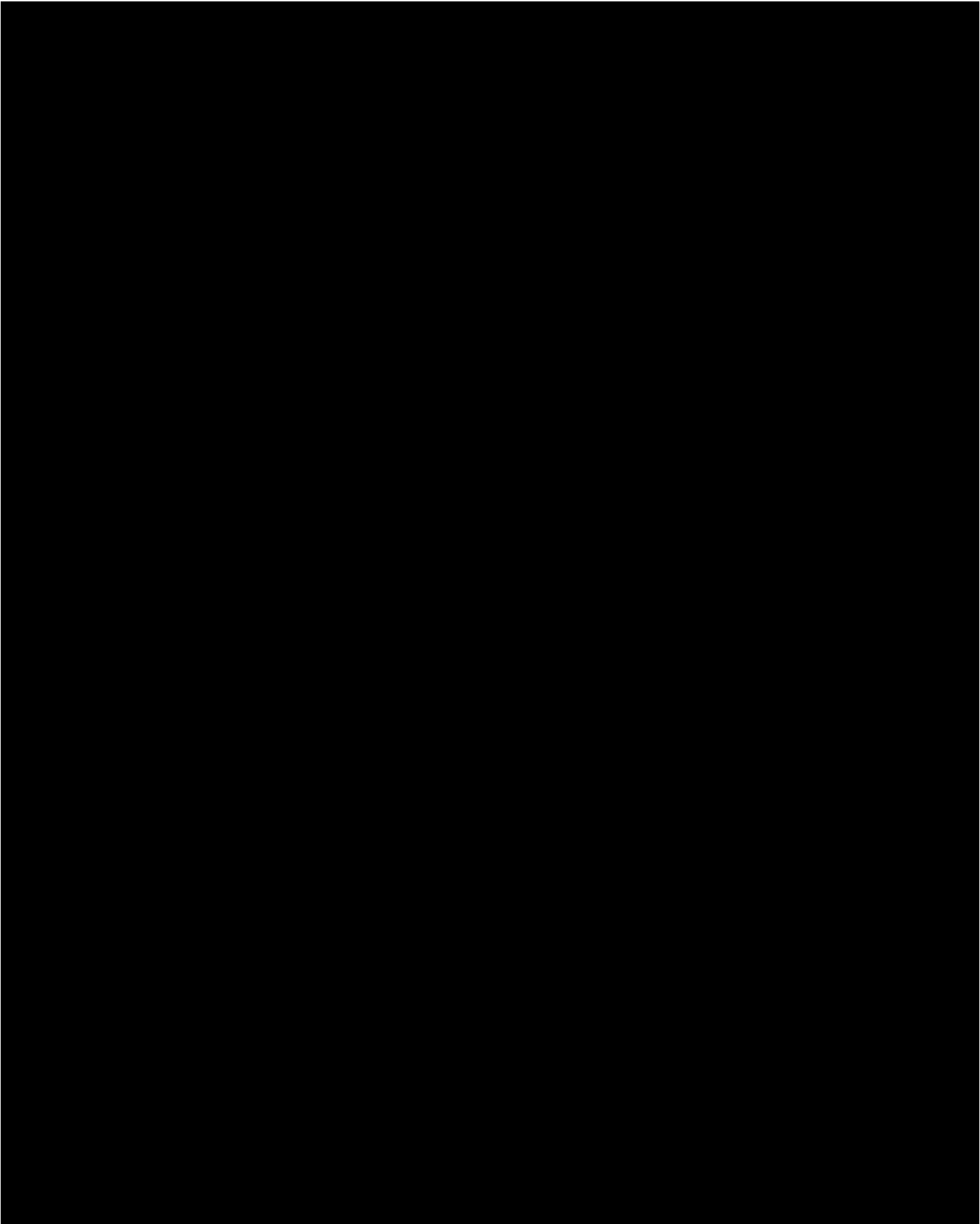


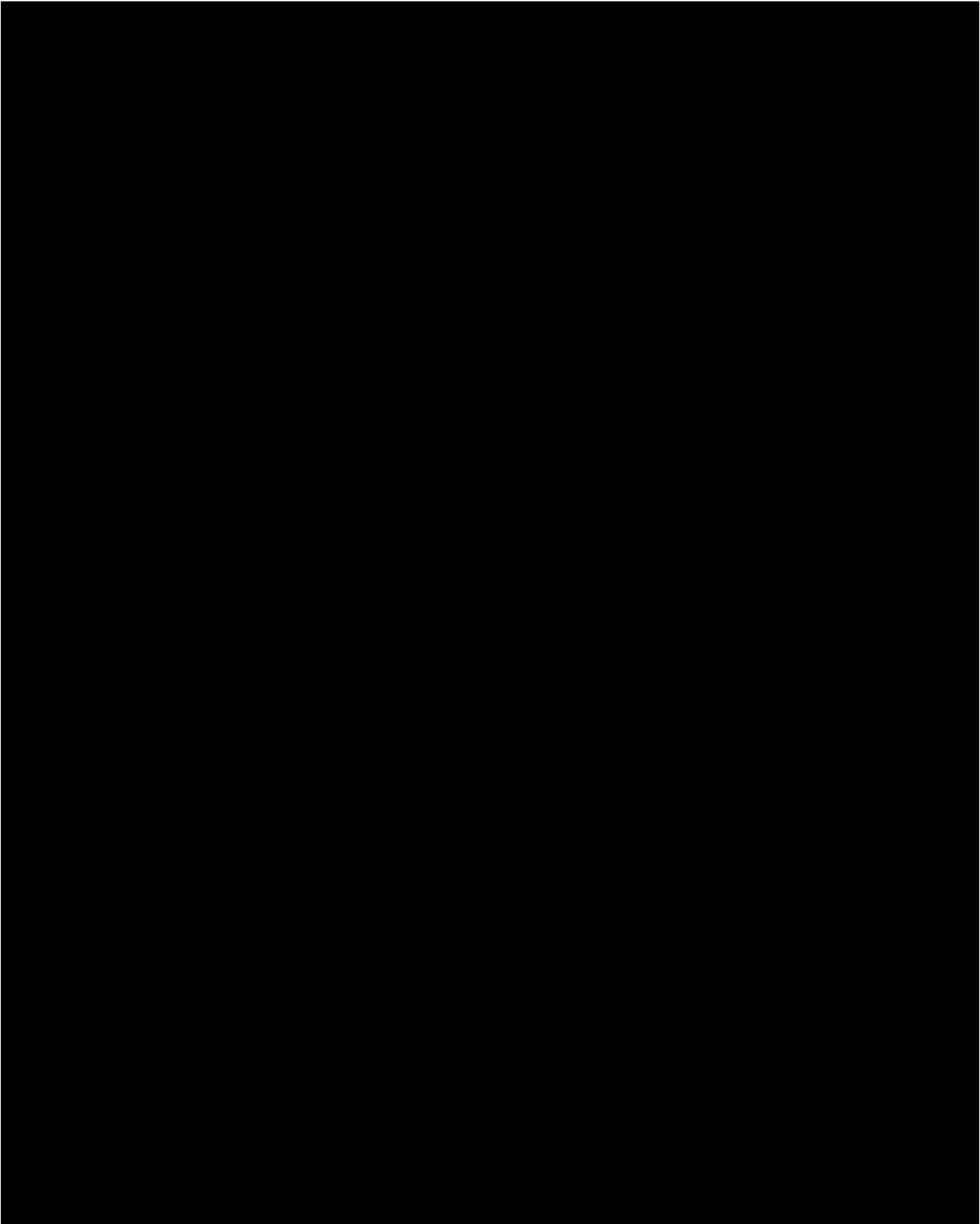


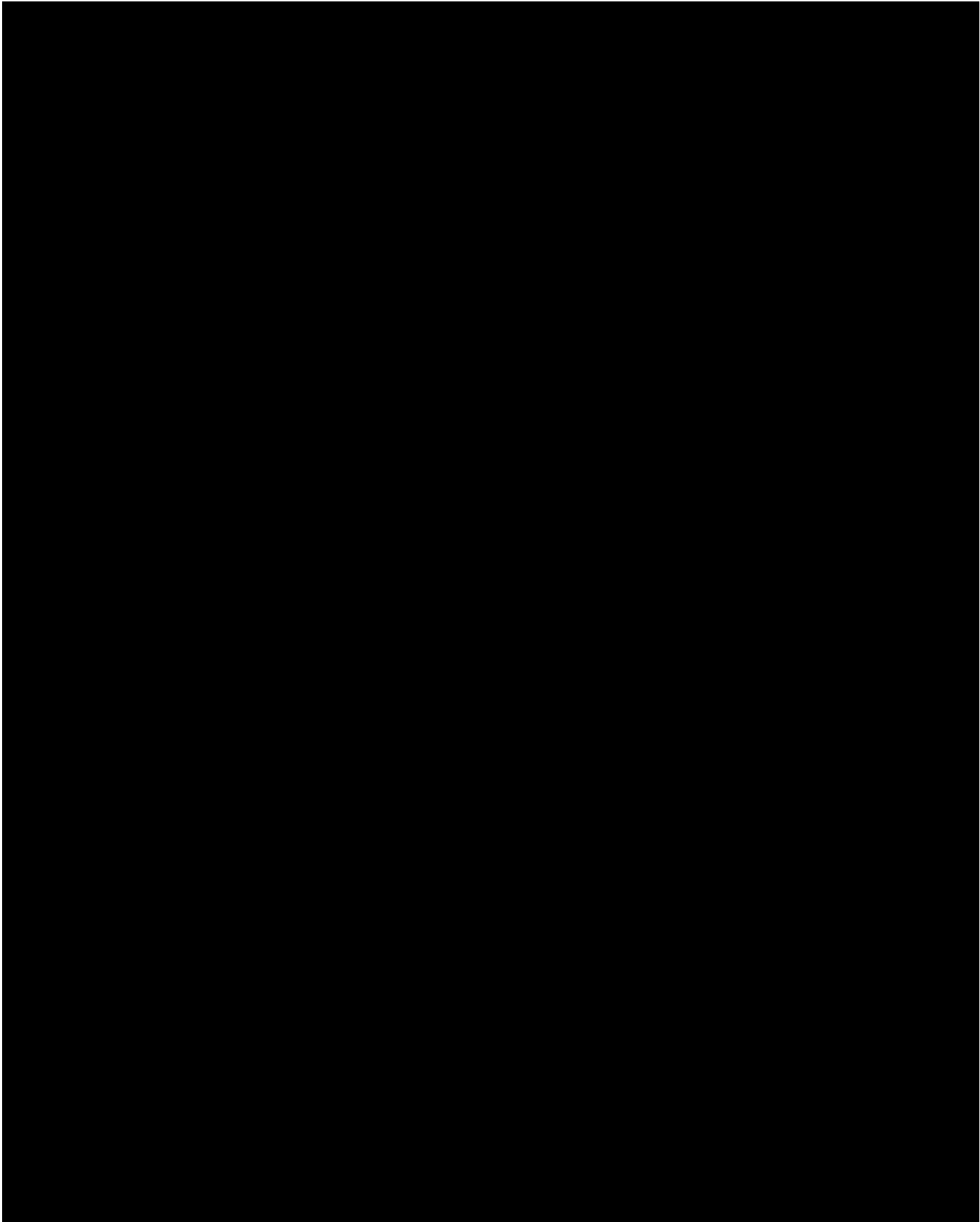


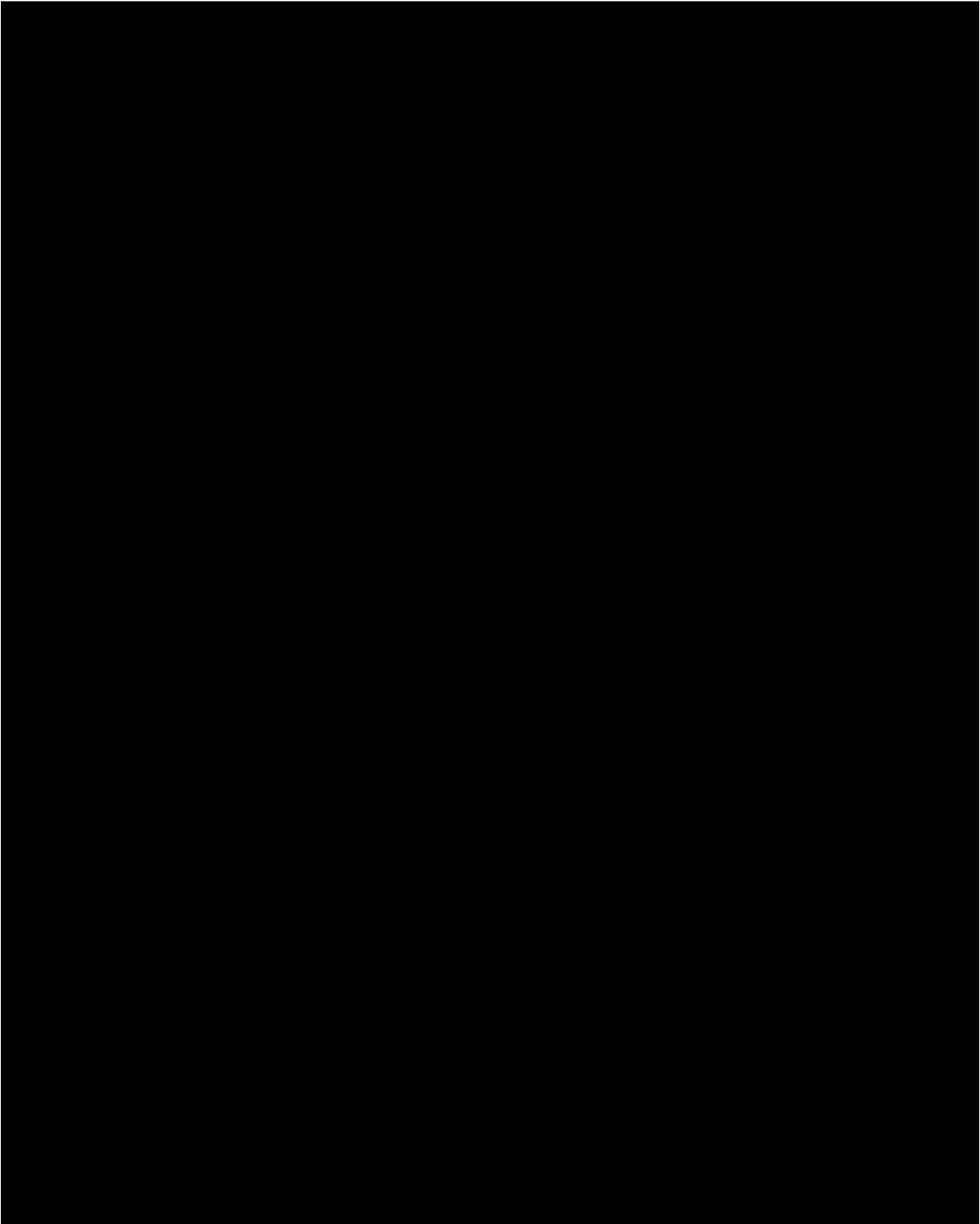


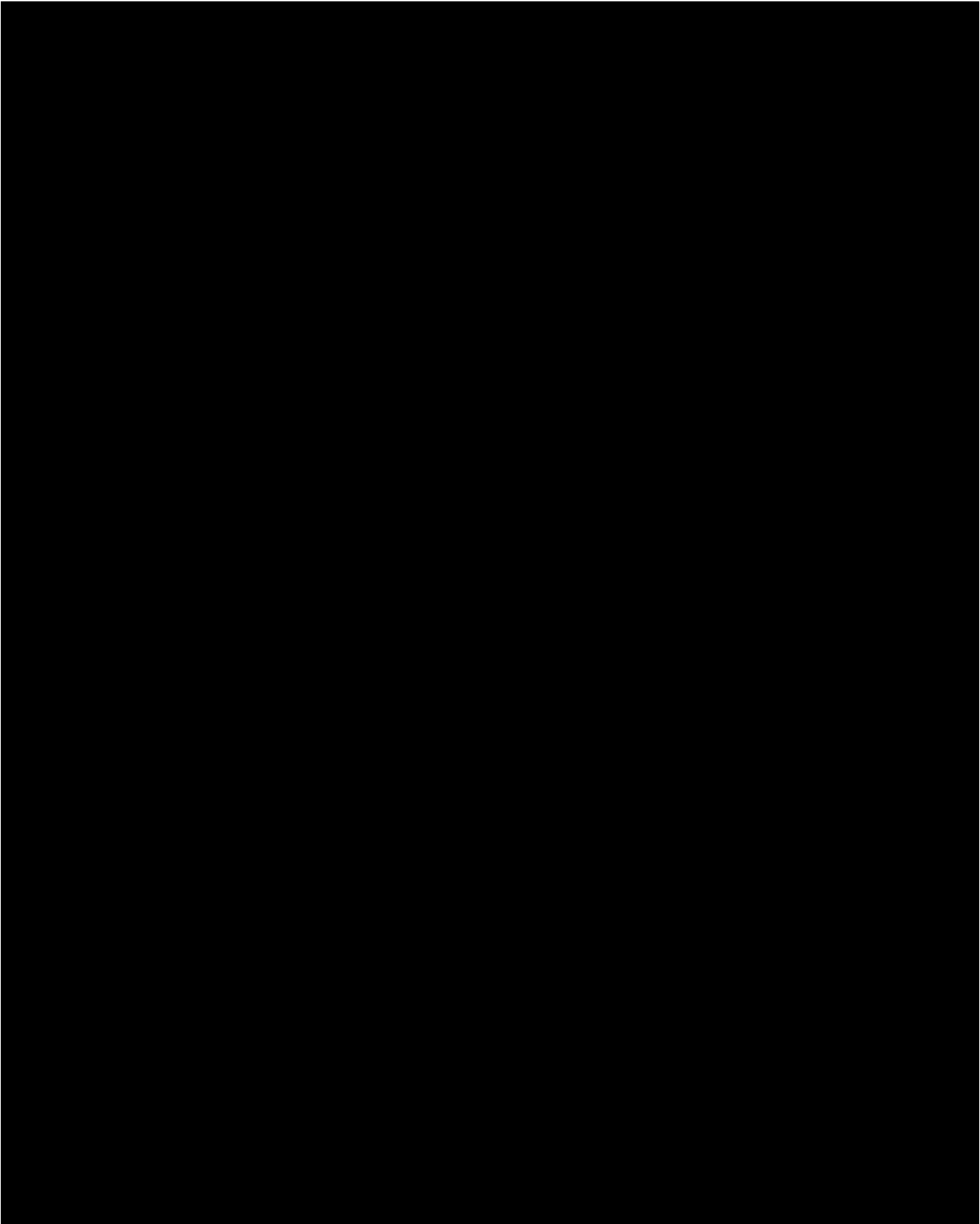


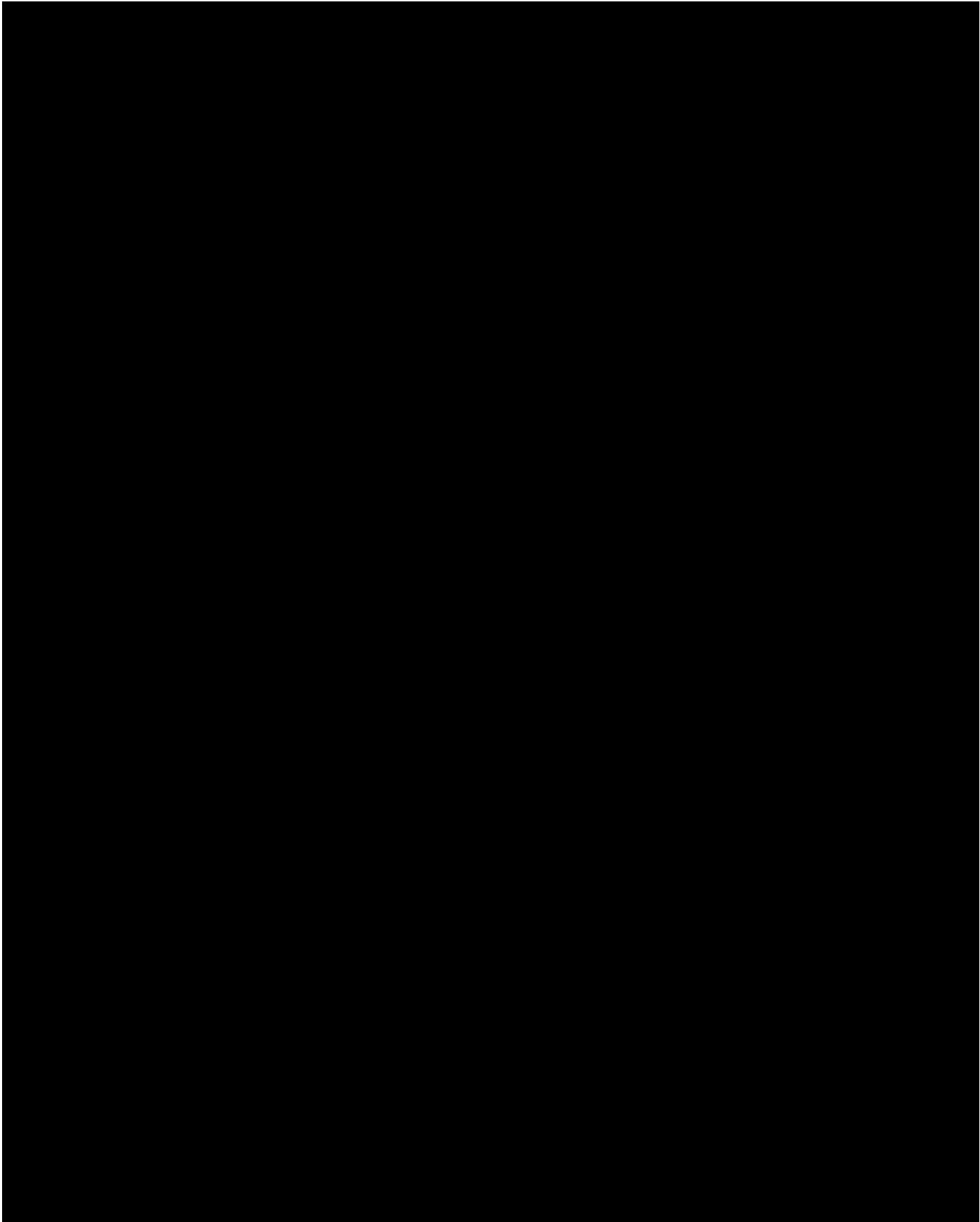


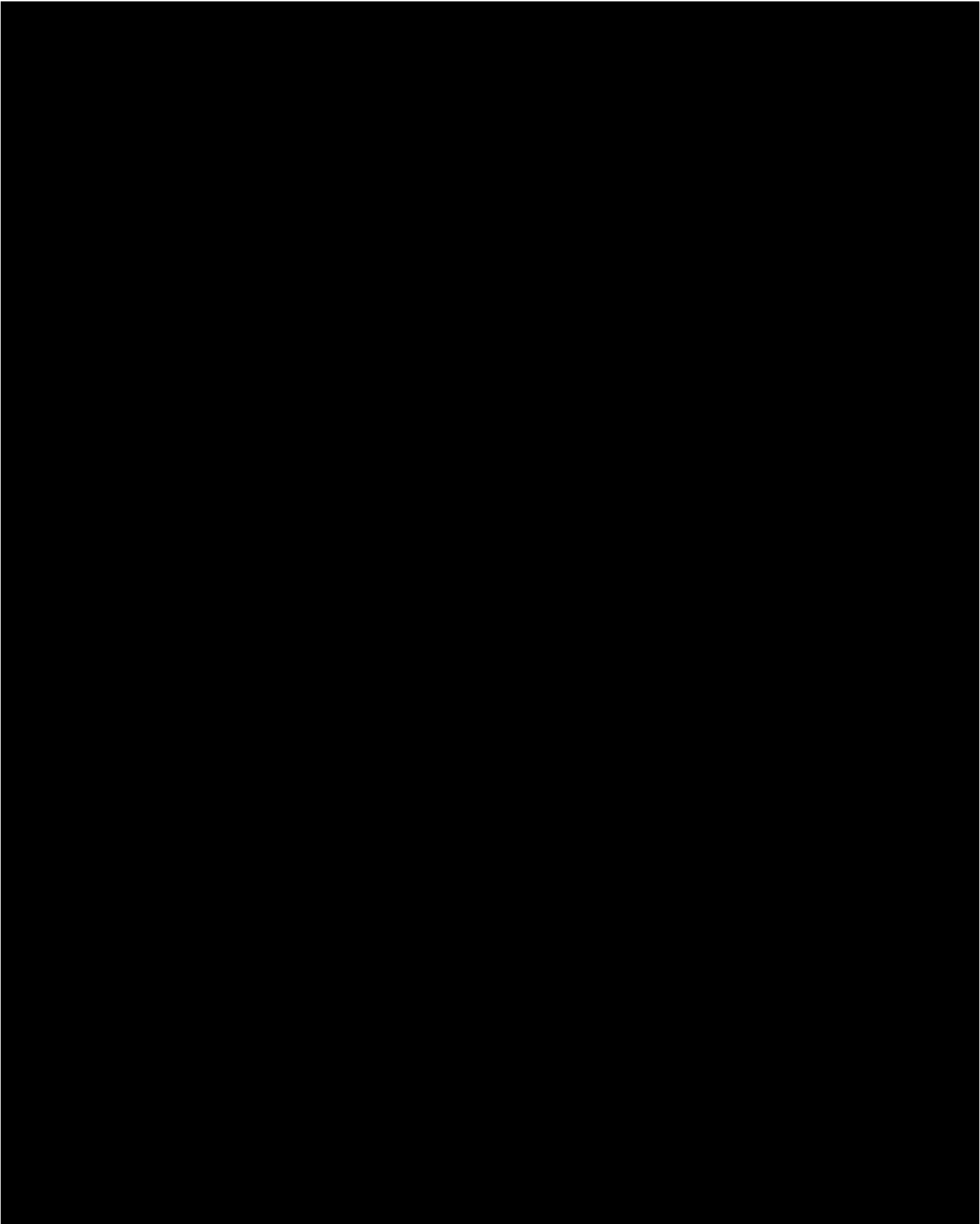


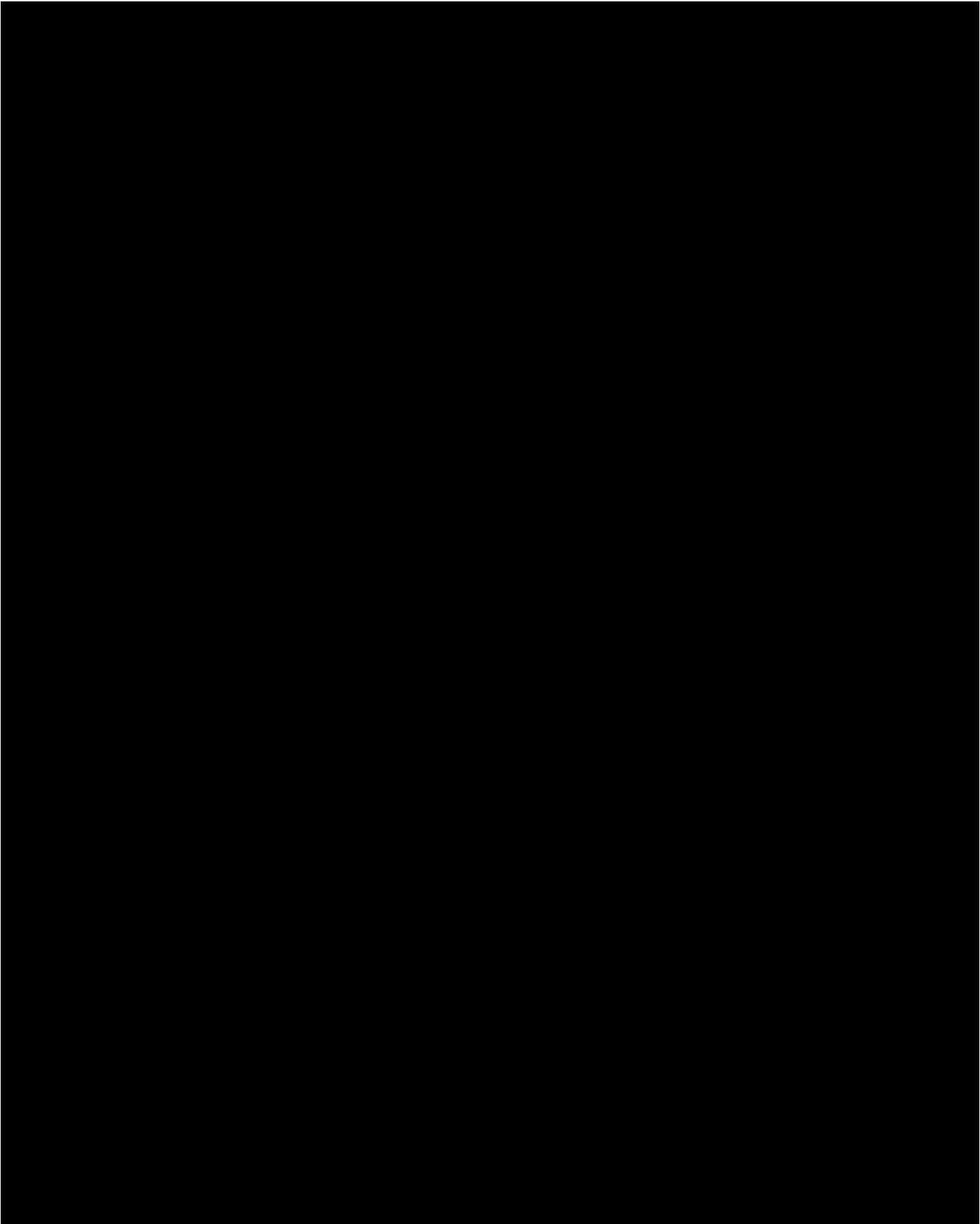


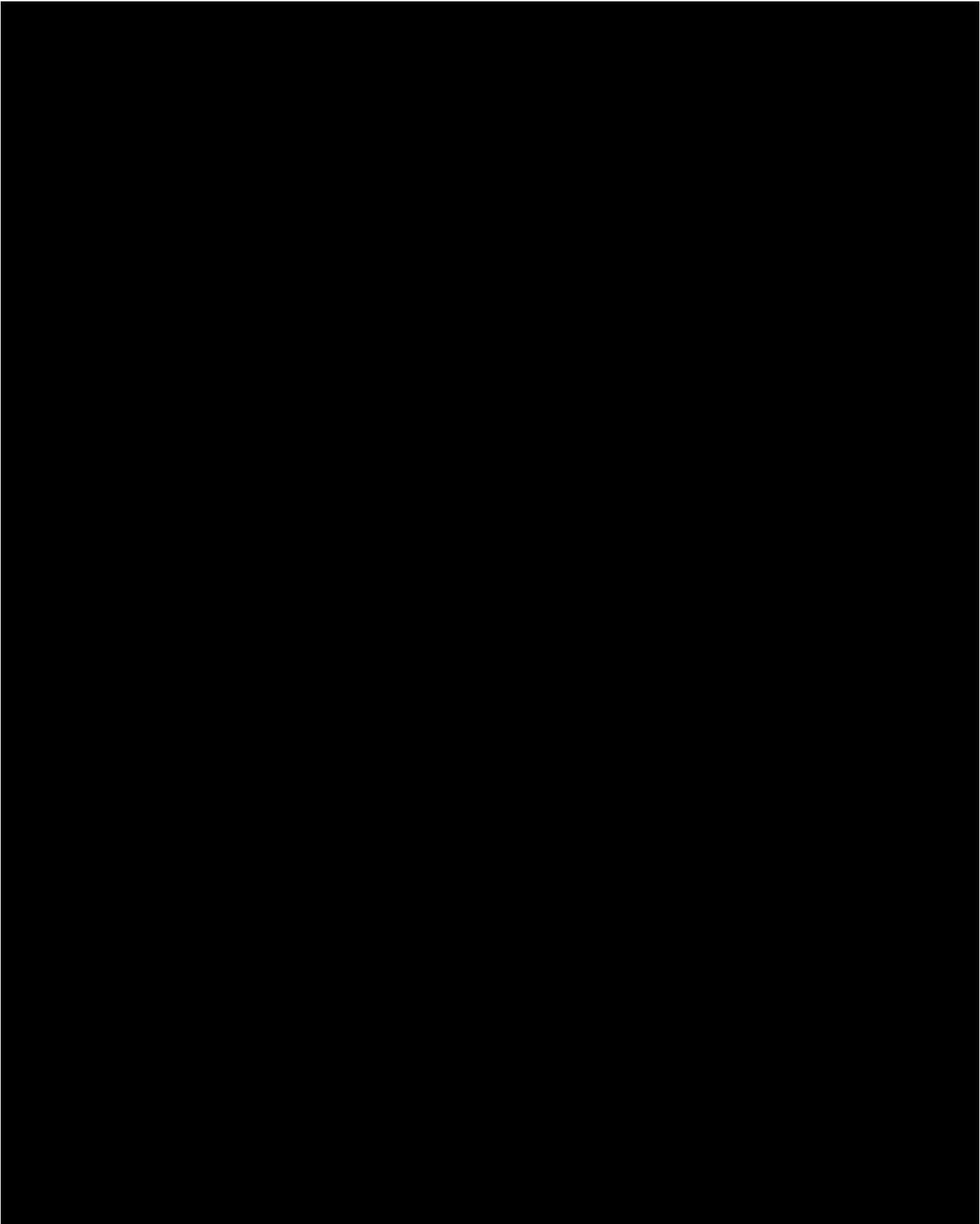


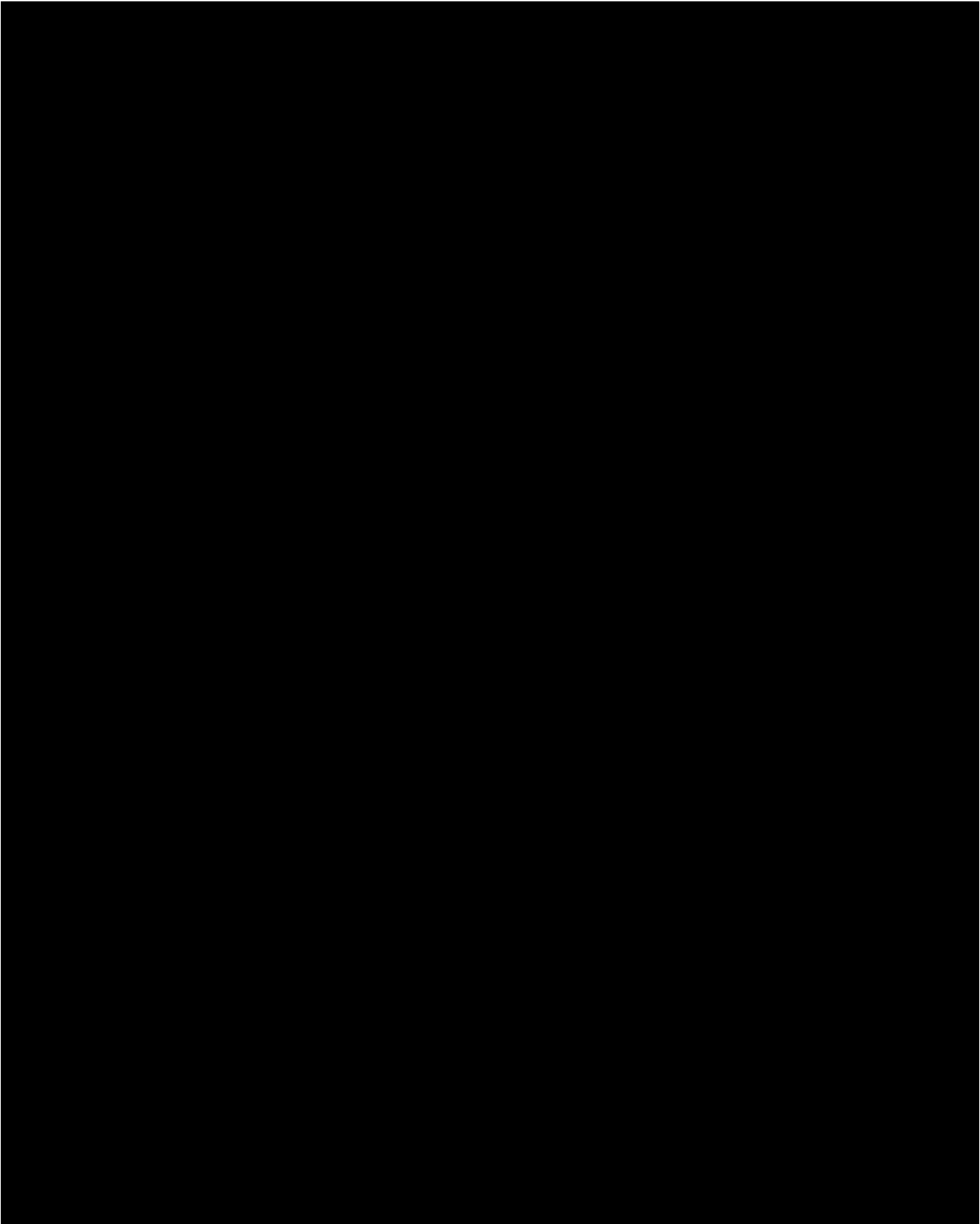


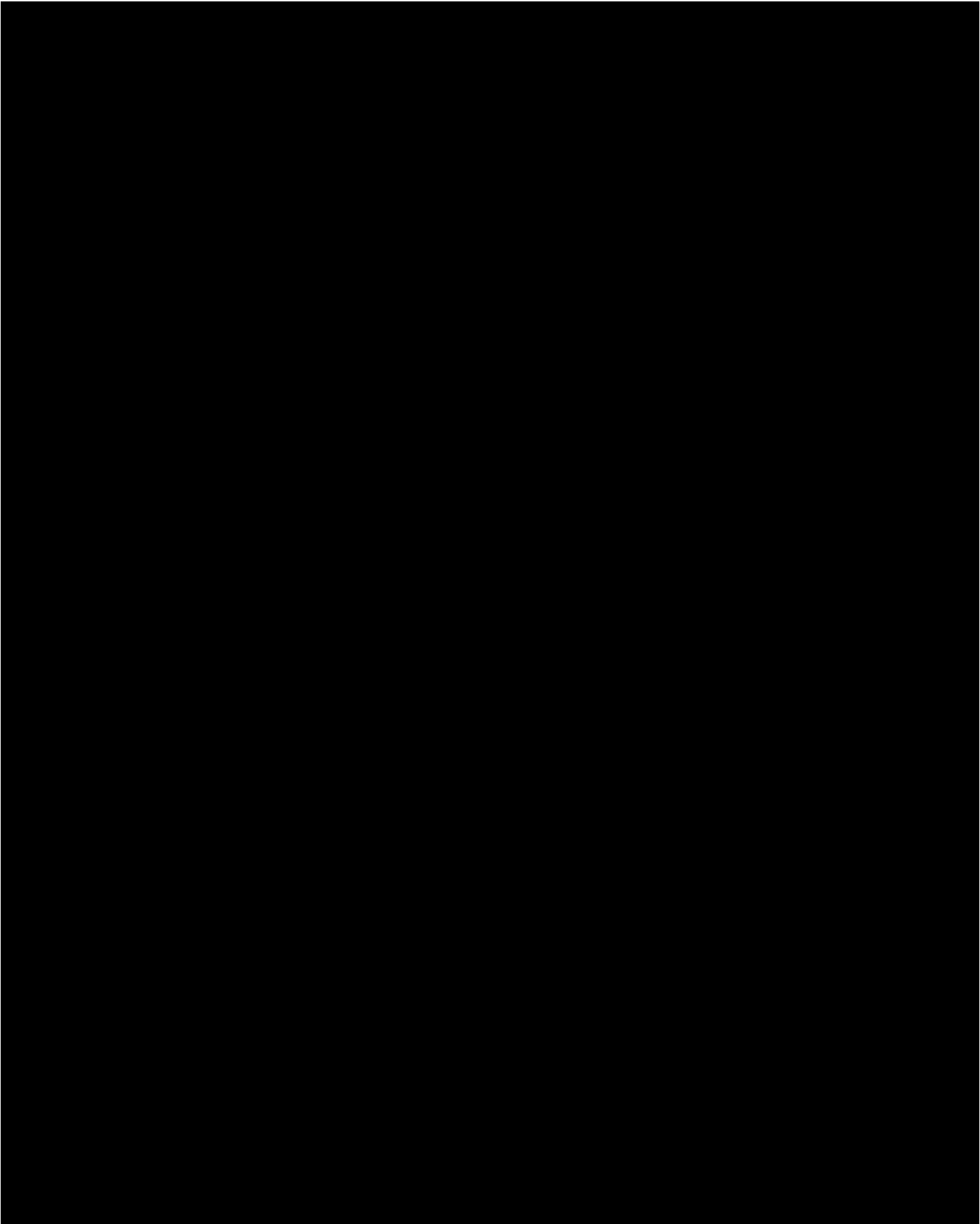


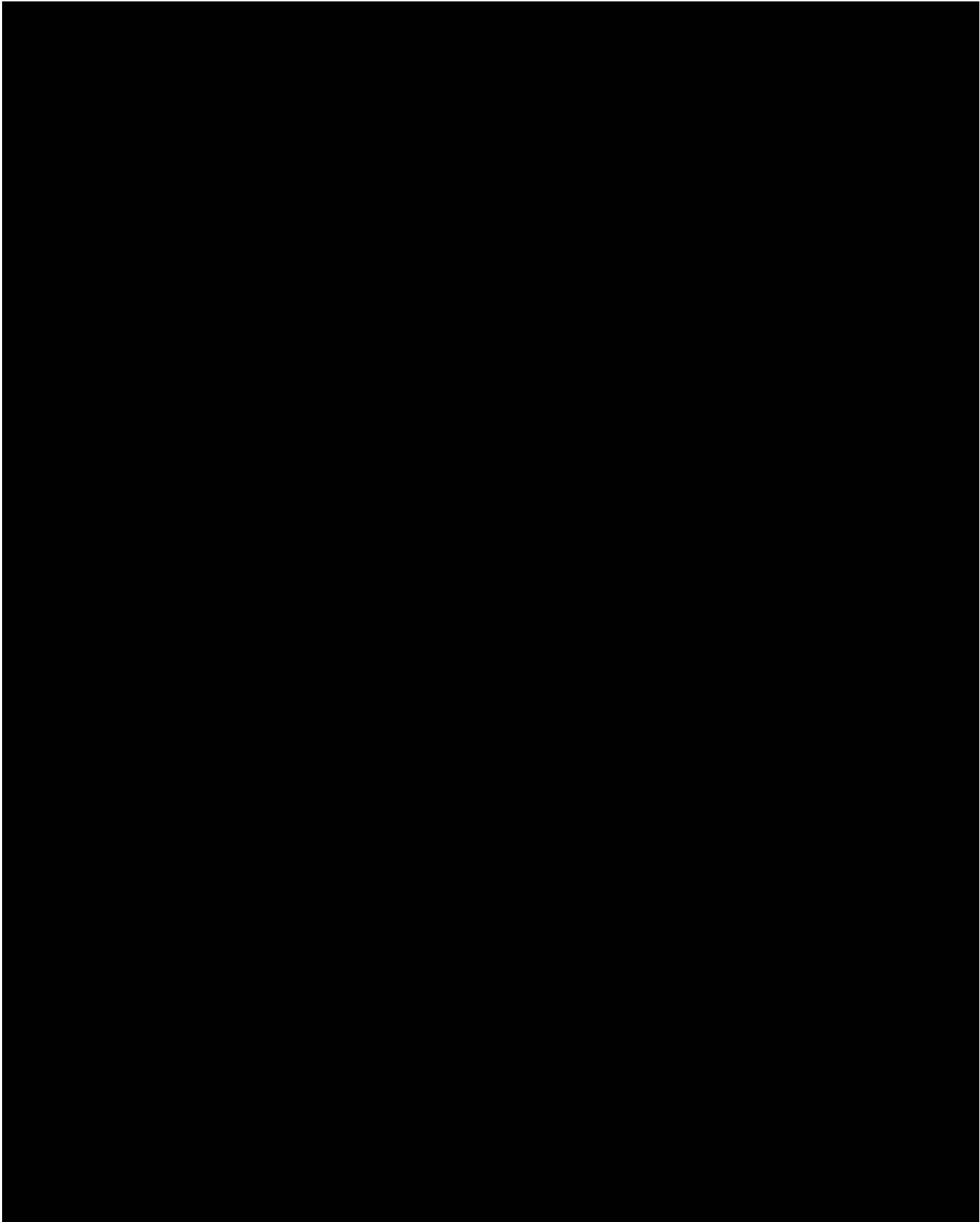


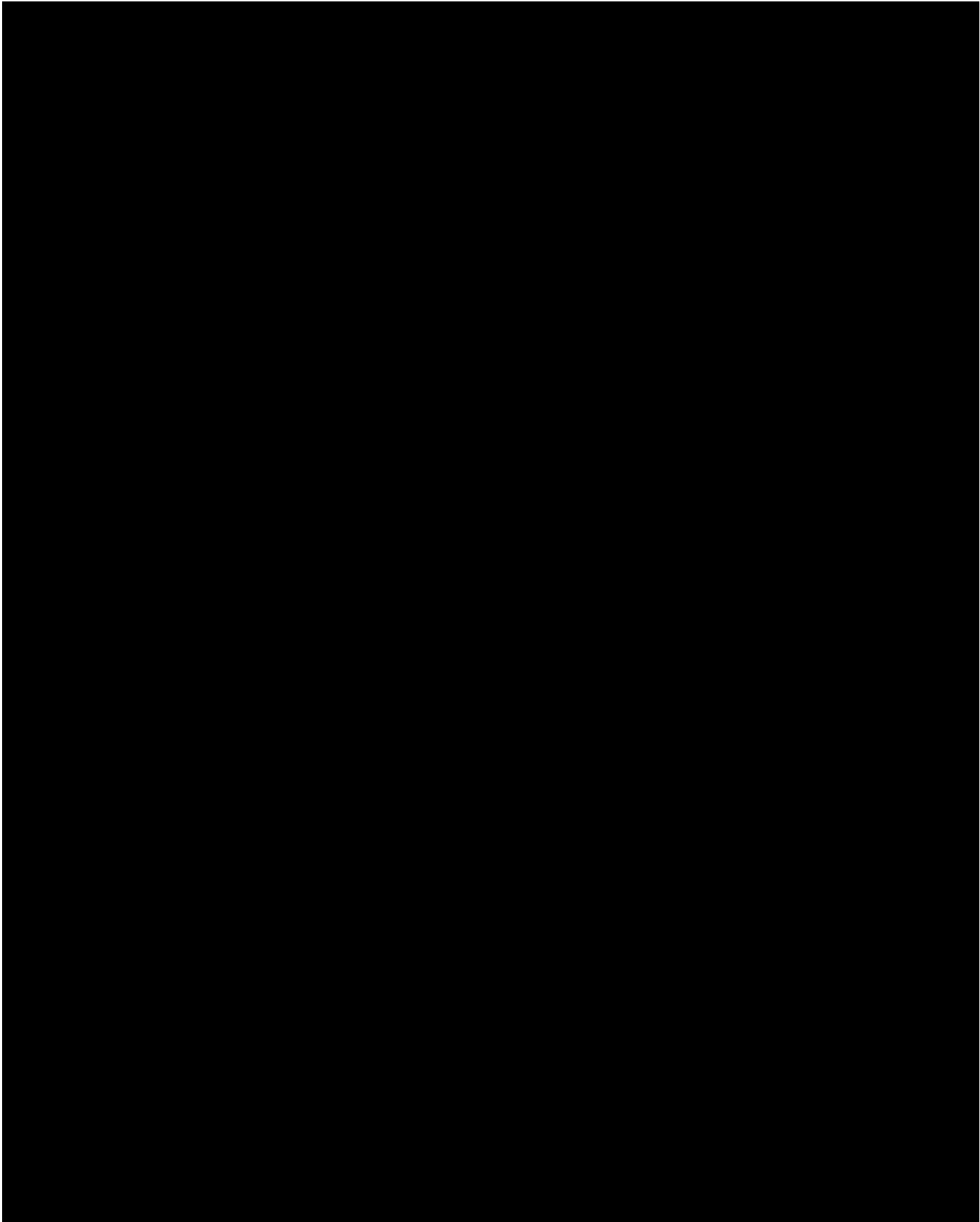


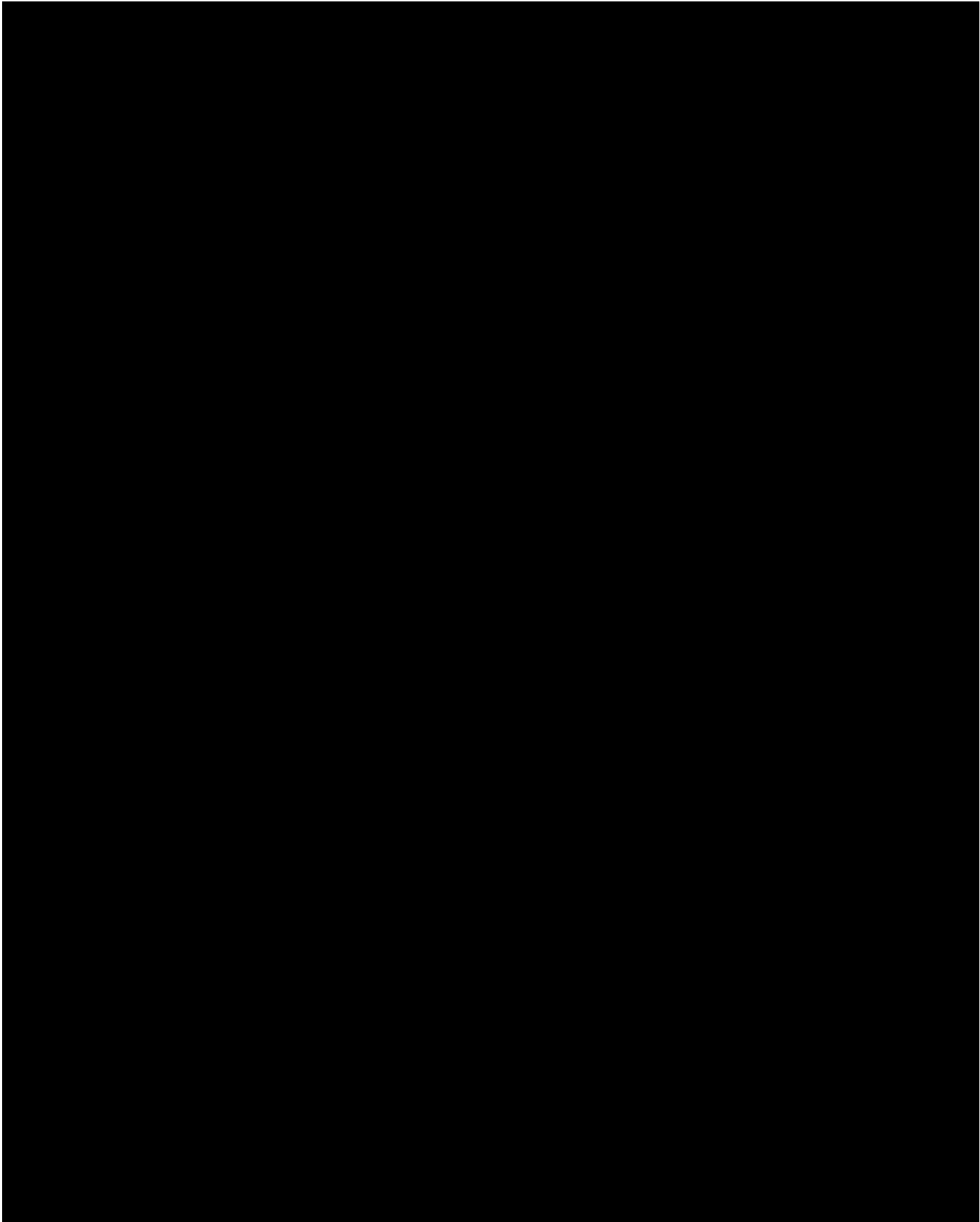


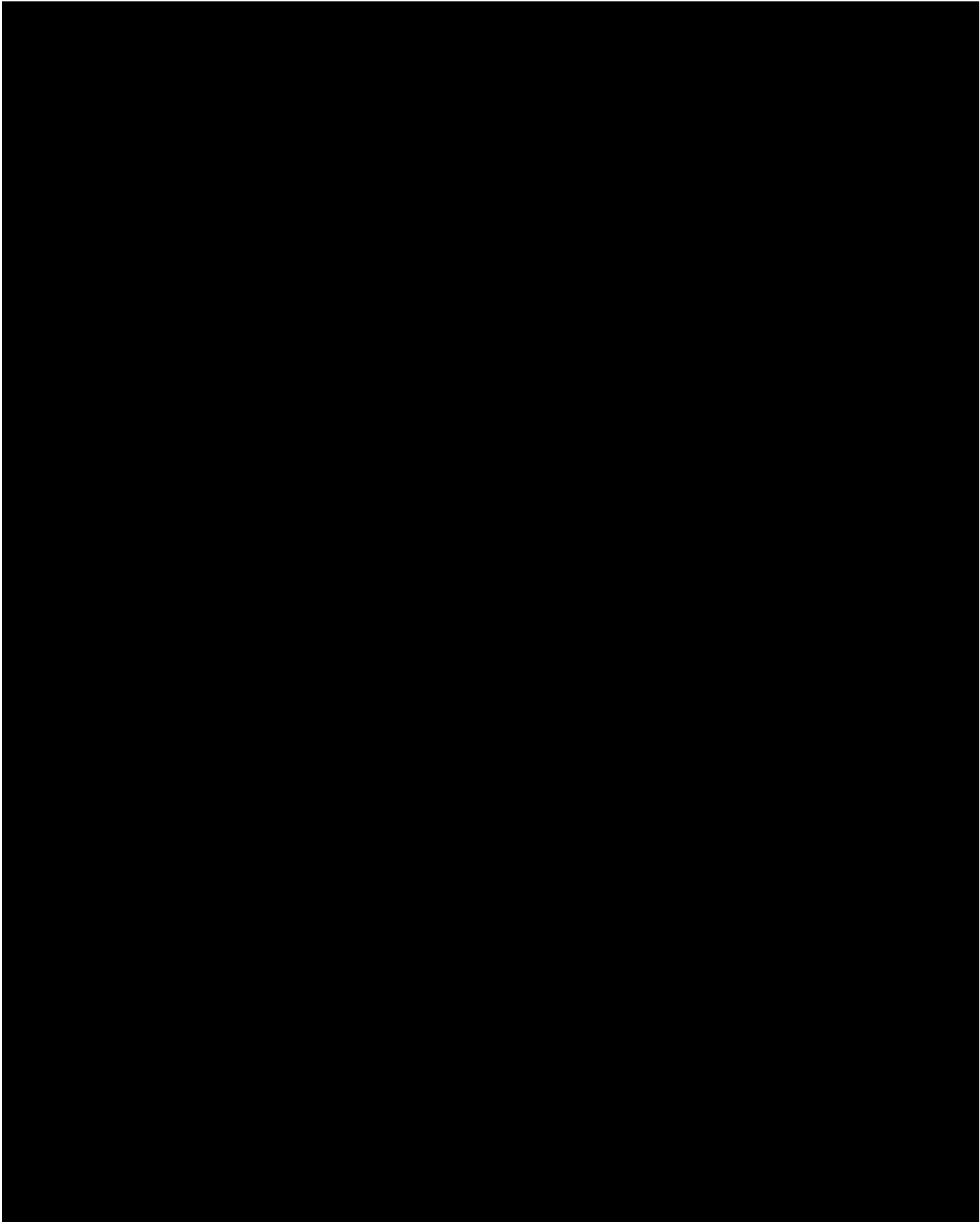


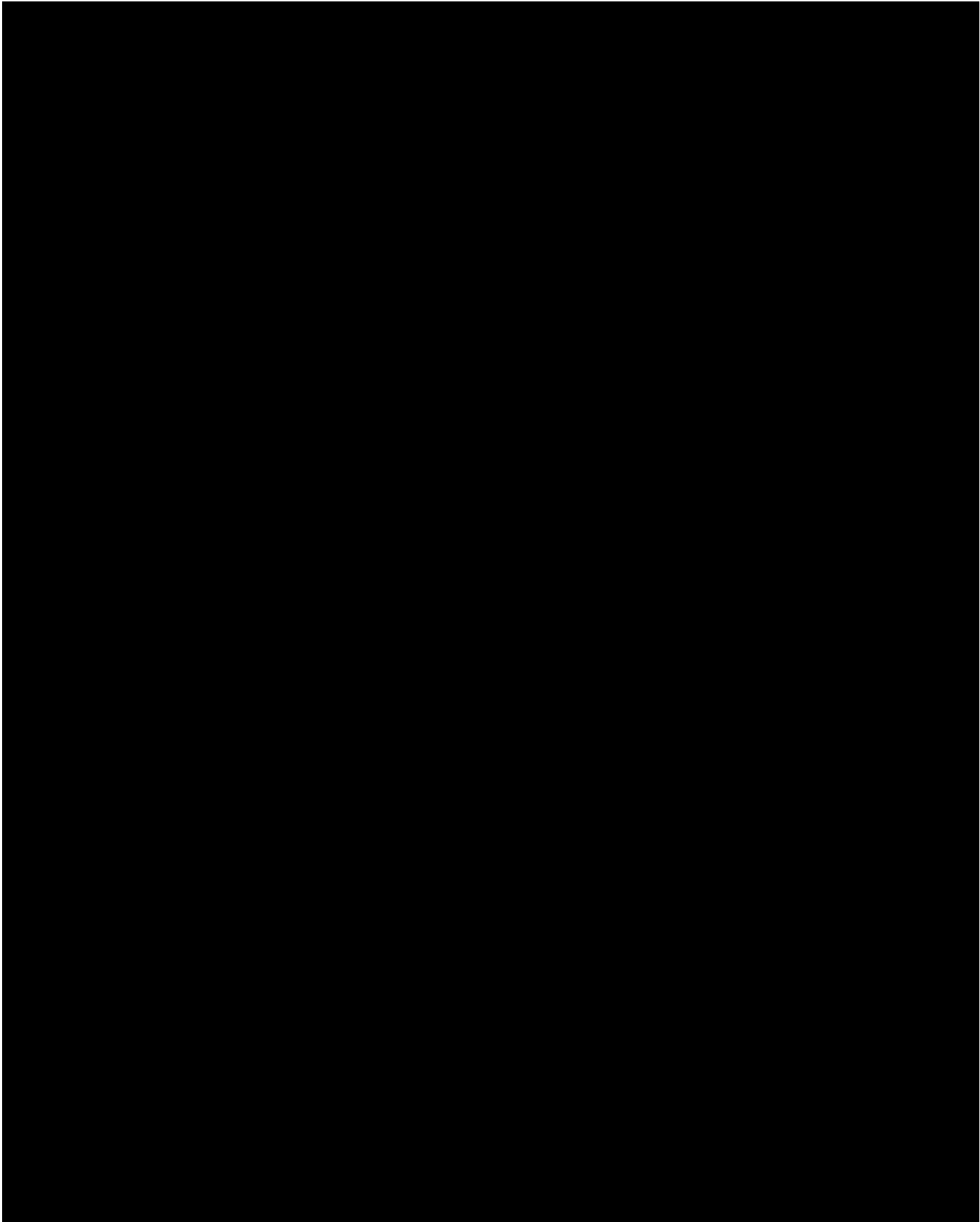


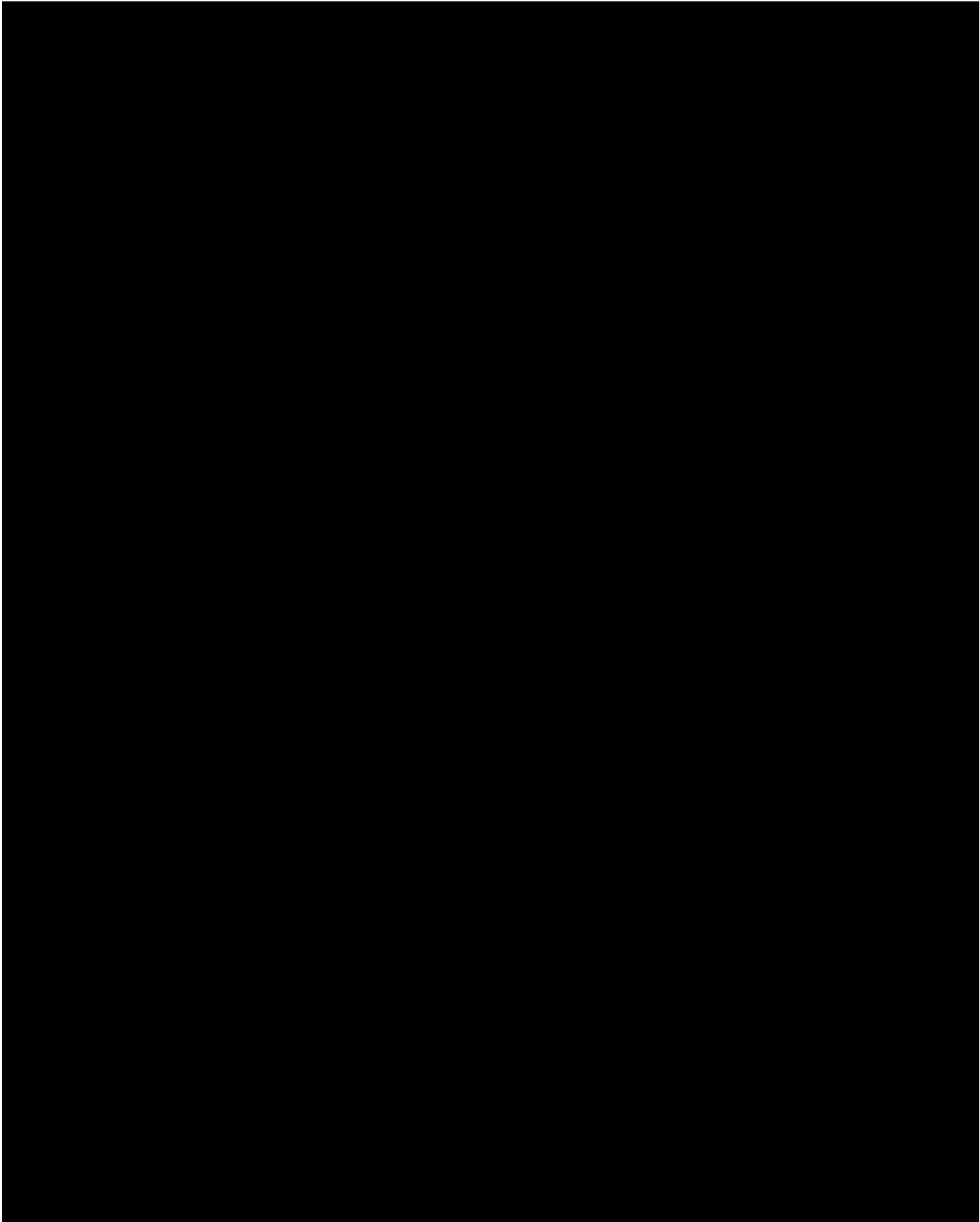












D. Prosecution history

The '177 patent was filed January 7, 2009 as U.S. Patent Application 12/349,802 ("'802 Application"). The '802 application was a divisional of U.S. Patent Application 09/550,644 ("'644 application"), filed on Apr. 14, 2000.

During prosecution of the '644 application, there as a restriction requirement and applicant elected to prosecute claims 1-12. Ex-2018.

On January 28, 2010, the patentee cancelled claims 1-12 and added new claims. Ex.-1002. On June 25, 2010, the USPTO issued a Notice of Allowability. *Id.*

VI. CLAIM CONSTRUCTION

A. Matched Filtering/Correlating Module

Claim 14 is directed to the matched filtering/correlating disclosed in Section IV of the '177 patent. See Section V.A. Section IV discusses the use of “match filter theory, sampling theory, and frequency domain techniques” in order to “down-convert an electromagnetic signal by repeatedly transferring energy from portions of the electromagnetic signal.” TI-1001, 129:61-67. Ex.-2024,¶173.

The matched filtering/correlating module is part of an energy transfer system. For example, the section of the '177 patent pertaining to a matched filtering/correlating module discloses “down-convert[ing] an electromagnetic signal by *repeatedly transferring energy* from portions of the electromagnetic signal.” *Id.*, 129:61-64. The patent also states “*the present invention operates by accumulating the energy* of a carrier signal and *using the accumulated energy*” *Id.*, 130:54-58. In the “Overview of *the Invention*,” the patent states that “[a] matched filtering/correlating process also *preserves the energy of the electromagnetic signal and transfers it through the processor.*” *Id.*, 130:37-39. Ex.-2024,¶174.

The patent also states that “the description of the present invention contained herein is a *unique and specific application of matched filter theory, sampling theory, and frequency domain techniques*. It is not taught or suggested in the present literature.” Id., 130:5-9.

The patent states “*the present invention is not a traditional realization of a matched filter/correlator.*” Id., 132:15-17. Contrary to how match filtering and correlating was traditionally used (Section III.B.10), the '177 patent applied match filtering/correlating to achieve direct down-conversion of RF signals, improving SNR through energy transfer. Whereas traditional matched filters/correlators used a sampler simply to transfer an information signal from analog time domain to digital domain, the '177 patent uses it to down-convert RF signals. Ex.-2024, ¶176.

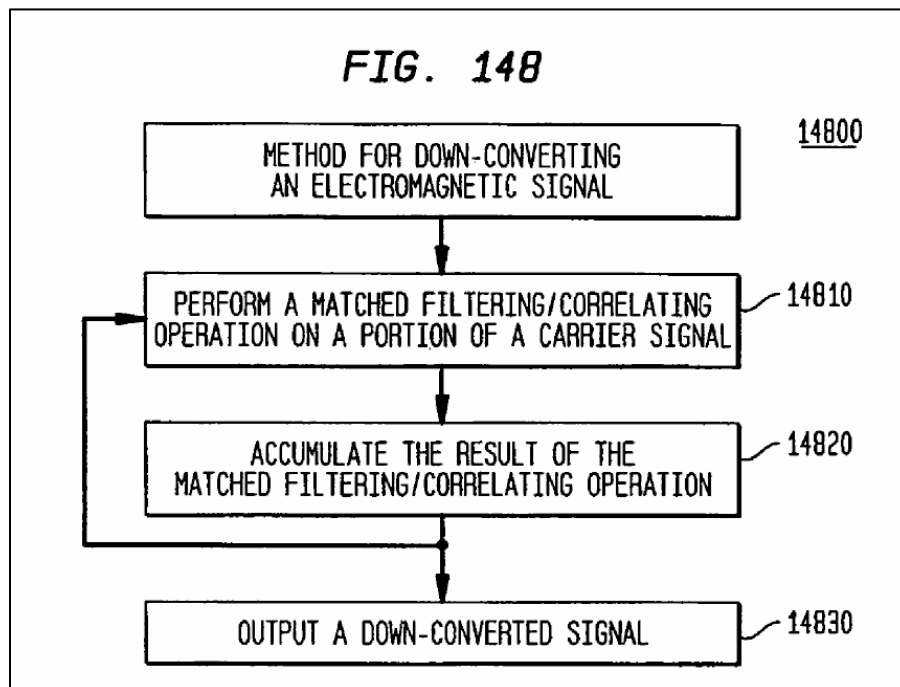


Figure 148 illustrates a method of down-converting an EM signal using a matched filtering/correlating operation. Id., 131:14-52.

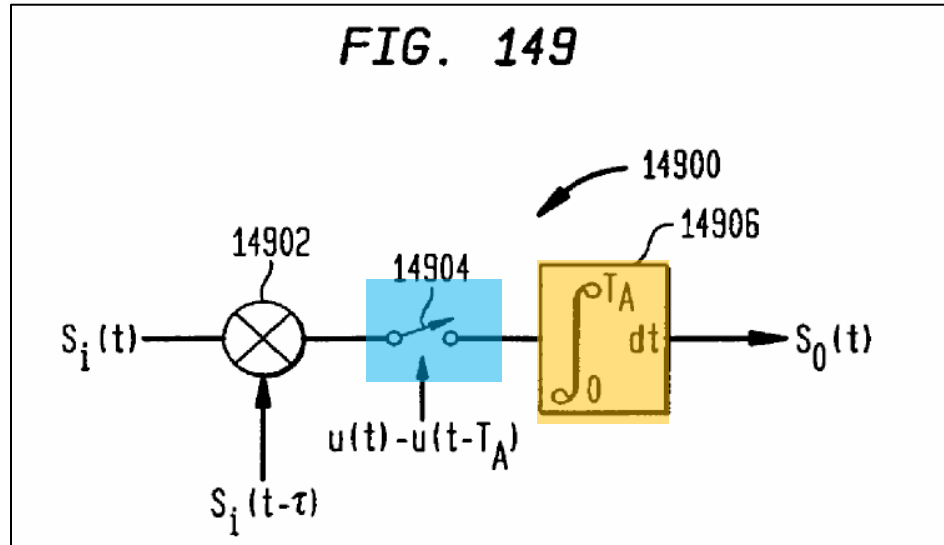


Figure 149 illustrates a matched filtering/correlating system 14900. The system 14900 includes a switching module 14904 (blue) and an integrator 14906 (orange). Id., 131:53-132:14.

Figure 150 discloses a method of down-converting an EM signal using a finite time integrator which can approximate a matched filtering/correlating operation. Id., 132:18-133:21.

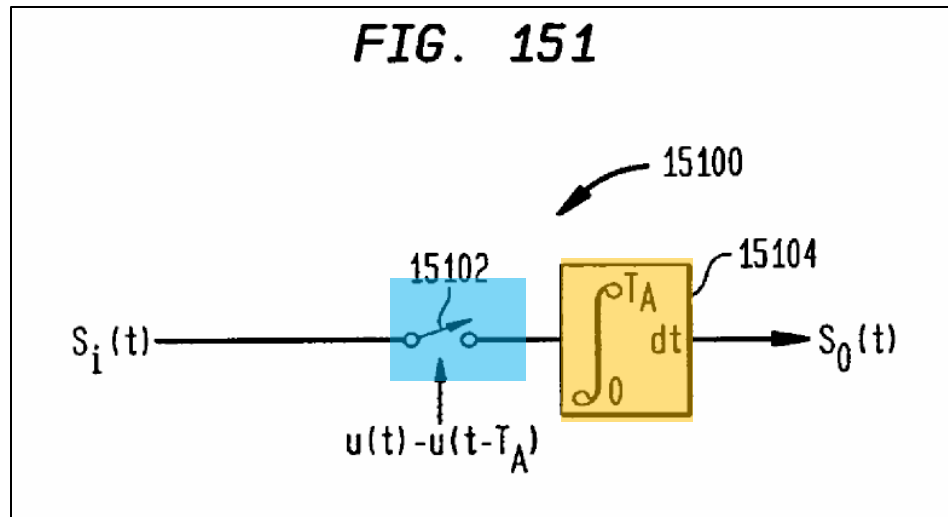


Figure 151 above includes a switching module 15102 (blue) and an integrator 15104 (orange).

Figure 152 discloses a method of down-converting an EM signal using an RC processor which can approximate a matched filtering/correlating operation. Id., 133:41-134:30.

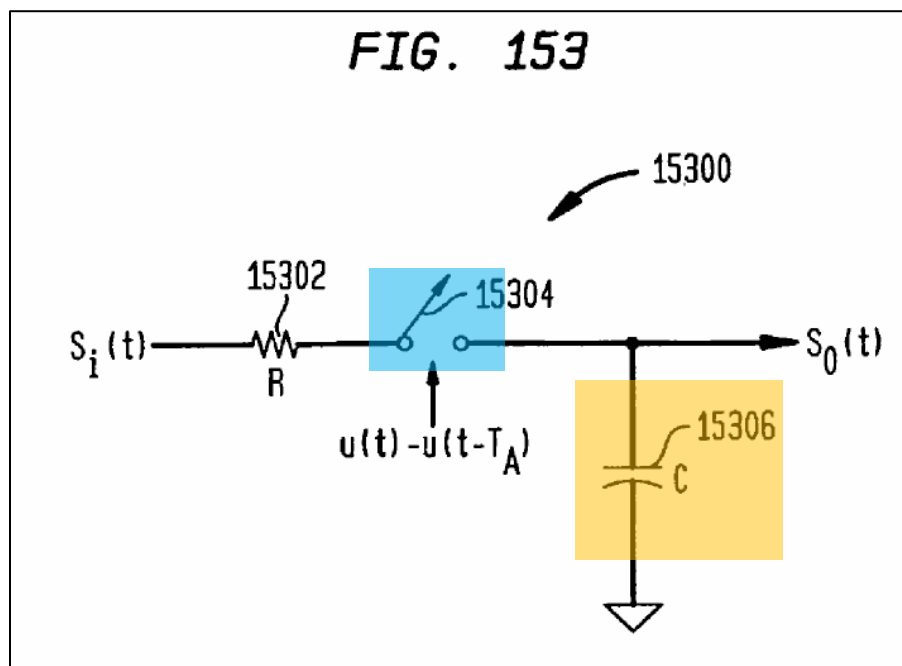
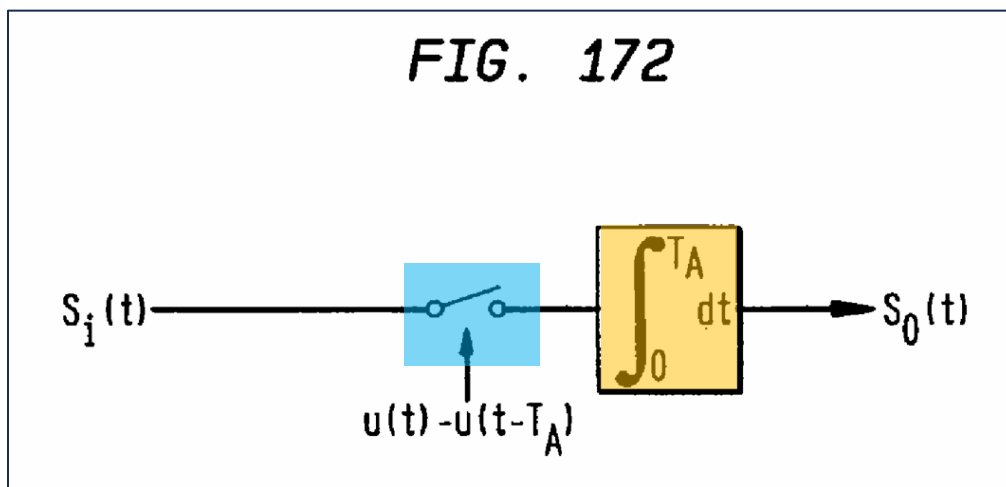
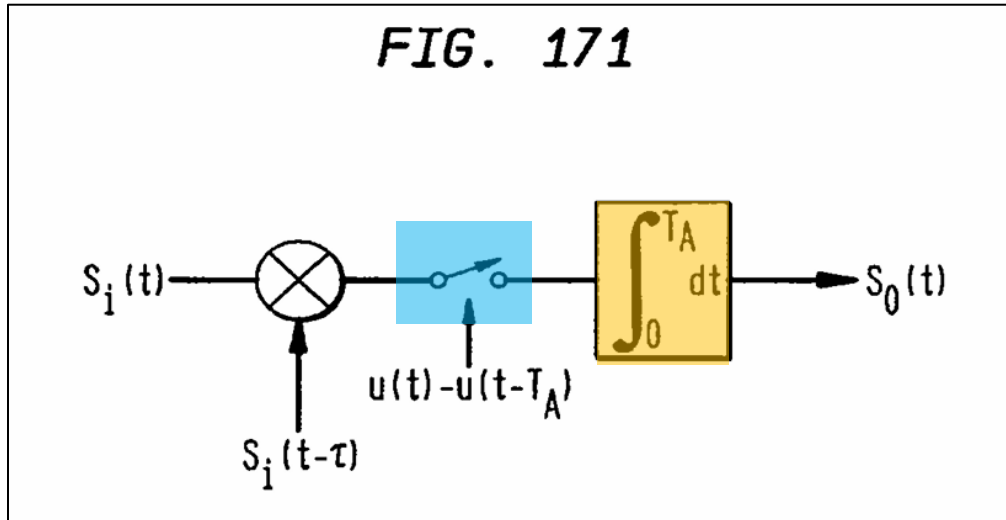


Figure 153 also includes a switching module 15304 (blue) and an integrator (capacitor 15306) (orange). Id., 134:31-55.



Figures 171 and 172 illustrate a matched filter/correlator. Id., 145:10-14, 40-45. This shows how a matched filter/correlator accomplishes acquisition of the energy available across a finite duration aperture. Id., 145:10-14. It includes a switch (blue) and an integrator (orange). Ex.-2024, ¶183.

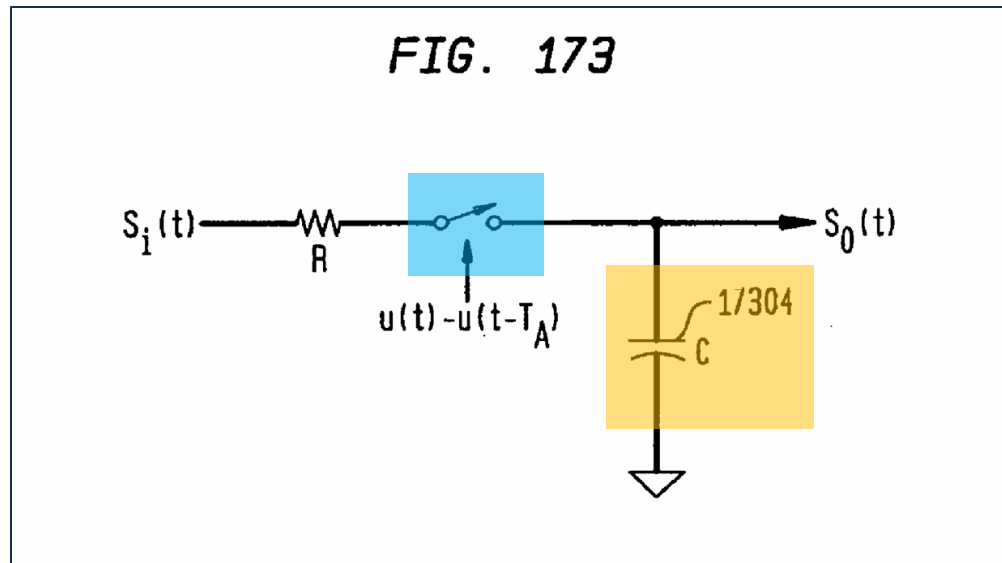


Figure 173 above illustrates that the integrator can be a capacitor 17304 (orange). Id., 145:46-55. Ex.-2024, ¶184.

Given the above, a POSITA understands that a matched filtering/correlating module includes a switch for sampling an input signal at an aliasing rate and that energy of the input signal is integrated. Ex.-2024, ¶185.

Further, a POSITA understands that in order for a matched filter/correlator to function as a matched filter/correlator, it must produce an enhanced signal-to-noise ratio (SNR). Id., 130:34-37 (“Operating on an electromagnetic signal with a matched filtering/correlating process or processor produces enhanced (and in some cases the best possible) signal-to-noise ratio[sp] (SNR) for the processed waveform.”). Ex.-2024, ¶186.

For a given signal with noise, matched-filter correlator provide the optimum SNR and “the output SNR from the matched filter depends on the *energy of the waveform $s(t)$* .” Ex.-2017, 376, 378; Ex.-2023, 88. $s(t)$ is the input waveform to the matched filter/correlator. Ex.-2024, ¶186.

A POSITA understands that the matched filter provides improved SNR for a given input signal with a given SNR. For RF systems, a POSITA knows to maximize the input SNR to the matched filter/correlator to obtain the highest SNR of the receiver system by transferring the maximum power from the antenna to the matched filter-correlator. This is achieved by have a matched real input impedance and a real output impedance of the matched filter/correlator. A load allows for a matched input impedance and to transfer maximum power from the antenna to the receiver, thus, enhancing SNR in the receiver. Ex.-2024, ¶187.

Given the above, a POSITA further understands that a matched filtering/correlating module of the '177 patent includes transferring energy to a load. Ex.-2024, ¶188.

During prosecution of the '644 application (of which '177 patent is a division), the Examiner issued a restriction requirement, breaking the claims into groups. Ex.-2018. The Examiner did not provide any reasoning for the groupings. *Id.* ParkerVision did not comment on/agree to the characterization of the Examiner's

groupings but simply chose to prosecute matched filtering/correlating embodiments discussed above.

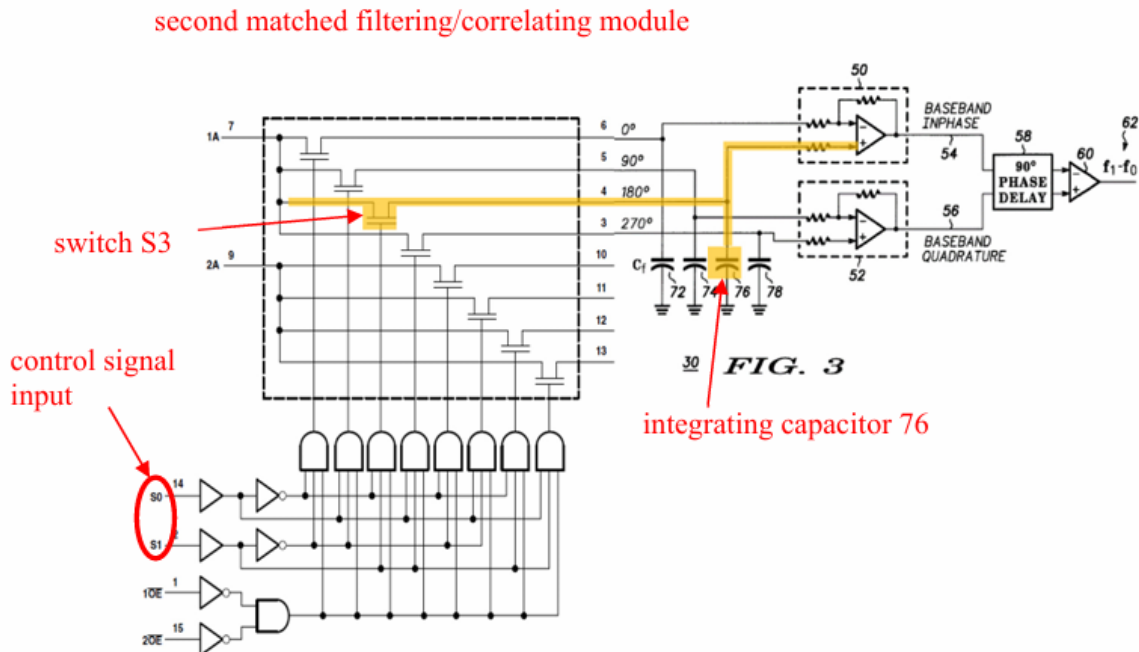
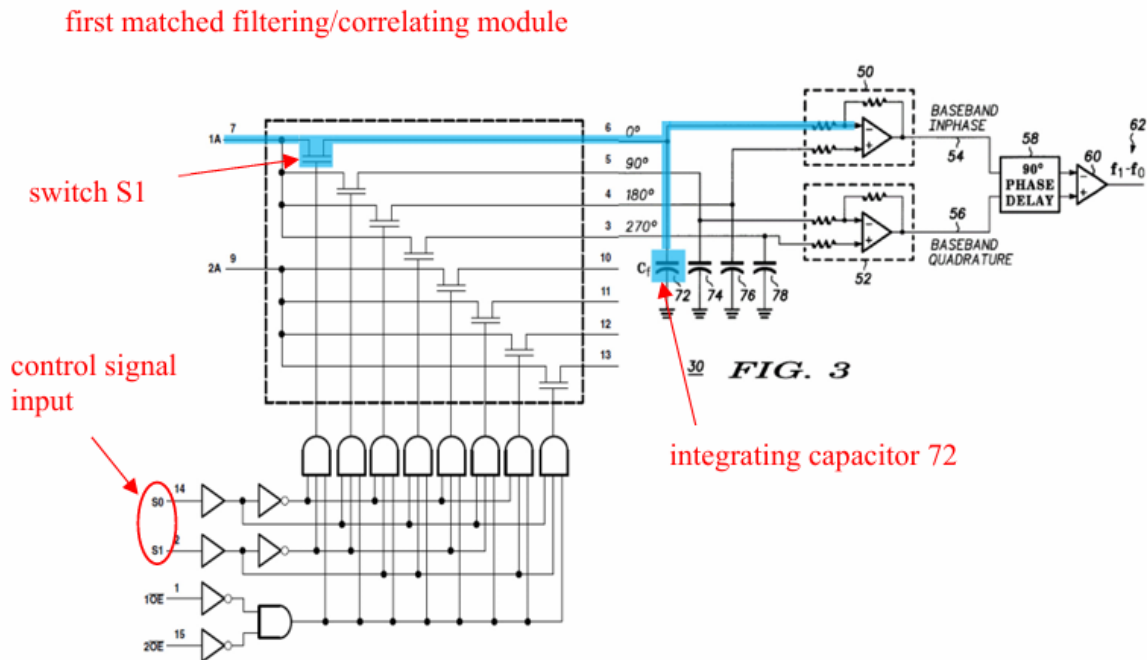
Dr. Galton acknowledges that the matched filtering/correlating module samples an input signal at an aliasing rate. Ex.-2034, 55:4-7. The District Court also construed “matched filtering/correlating module” to have “its plain-and-ordinary meaning wherein the module samples an input signal at an aliasing rate.” Ex.-2035, 41 (adopted Ex.-2006).

Dr. Galton agrees that “[a]nother common characteristic of a matched filtering/correlating module *across all implementations* is that ‘the result of the matched filtering/correlating operation ... is *accumulated*, preferably in an energy storage device[,]’ and that these steps ‘are repeated for additional half cycles [or portions thereof] of the carrier signal.’” TI-1003, ¶63. Dr. Galton also pointed to figures from a textbook showing that a matched filter/correlator has a switch and integrator. TI-1003, ¶22. Ex.-2024, ¶190.

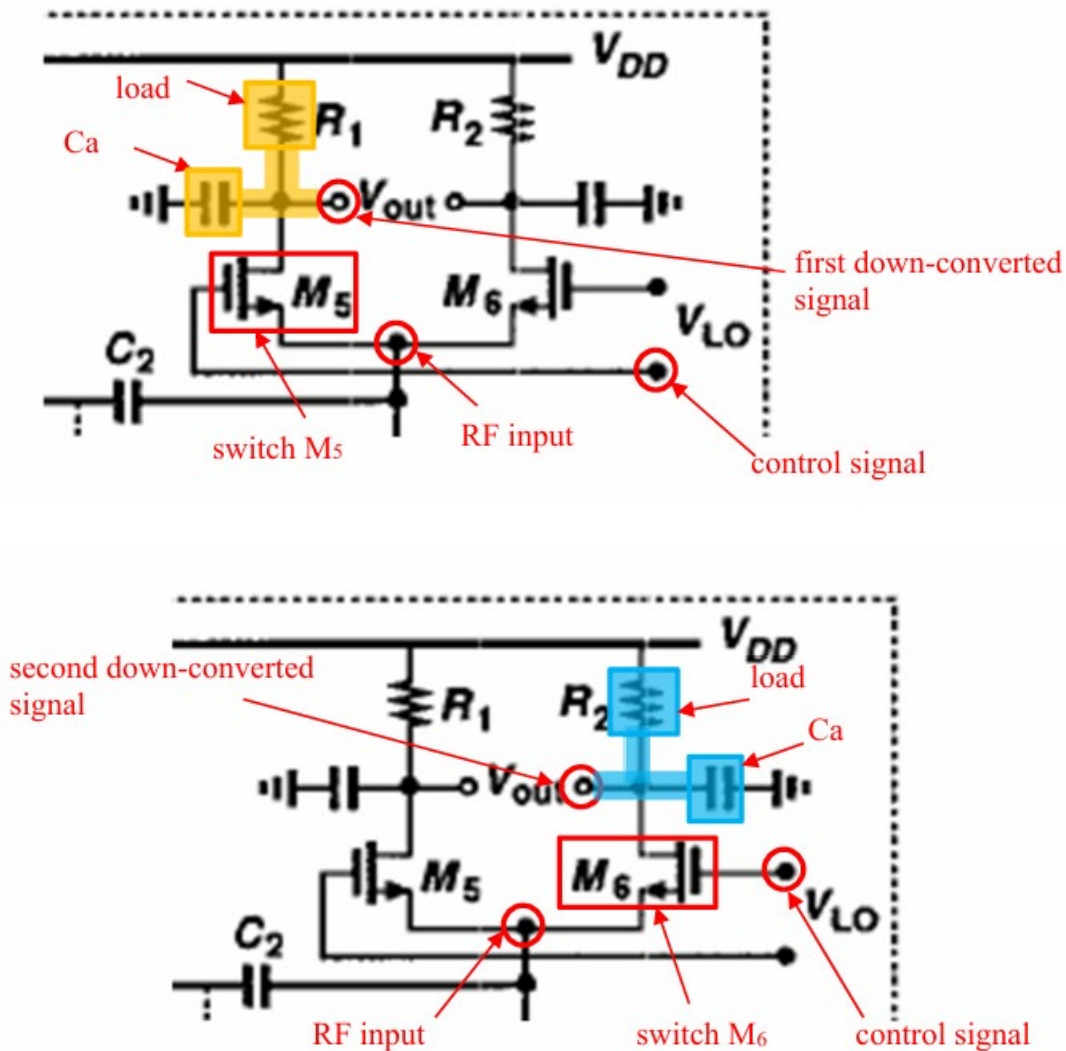
Dr. Galton also identified a switch, integration, sampling, synchrony, and certain mathematics as being features to a matched/filter correlator. Ex.-2034, 26:16-27:16; 27:2-16 (referring to Figure 172 where a switch is closed/opened at an aliasing rate and then integration occurs); 32:6-33:11. Ex.-2024, ¶191.

As shown below, with regard to Tayloe, Dr. Galton (under his construction of matched filtering/correlating module) identifies a switch, a capacitor and a load

(resistor) making up each matched filtering/correlating module (which Dr. Galton shows in light blue and orange). TI-1003, ¶¶136, 149-151. Ex.-2024, ¶192.



As shown below, with regard to Razavi, Dr. Galton also identifies a switch, a capacitor, and a load (resistor) making up each matched filtering/correlating module (which Dr. Galton shows in light blue, orange and red boxes). TI-1003, ¶¶174, 185. Ex.-2024, ¶193.



Dr. Galton acknowledges that Figure 151 and 153 of the '177 patent show a matched filtering/correlating module. TI-1003, ¶¶132, 134.

In view of the foregoing, the experts agree that “matched filtering/correlating module” must include at least a switch, integrator (capacitor), and load (resistor), must sample an input signal at an aliasing rate, and must integrate energy of the input signal. As discussed above, a load must be associated with the module of the ’177 patent in order to produce an enhanced SNR (an aspect of a matched filter) of a receiver. Ex.-2024, ¶195.

In view of the foregoing, a POSITA would understand that the construction of “matched filtering/correlating module” is “circuitry that samples an input signal at an aliasing rate using a switch such that energy of the input signal is integrated and transferred to a load to form a down-converted signal.” Ex.-2024, ¶196.

Sampling refers to reducing a continuous-time signal to a discrete-time signal. See Ex.-2030; Sections III.B.11, V.B. Ex.-2024, ¶198.

Moreover, a POSITA understands that the meaning above is also the plain and ordinary meaning of “matched filter/correlator.” These are all features that are similar (as required by Dr. Galton’s construction) to those of a matched-filter/correlator in the plain-and-ordinary meaning of the term. Ex.-2024, ¶197.

Finally, the Florida Court construed “matched filtering/correlating module.” Ex.-2007, 24. See also e.g., TI-1001, 175:50–51; 26:23-28; 130:23-27, 132:1-3, 133:29-34, 134:37-44; 147:35–42, 148:17–24; 148:25–33, 148:34-149:19; 130:31–37. While the constructions provides additional details, this construction also

captures the meaning of “matched filtering/correlating module.” Ex.-2024,¶¶199-200.

B. Dr. Galton's Construction

Dr. Galton's construction of “matched filtering/correlating module” is wrong. His construction is vague, ambiguous, and incorrect – what are “similar features” and why does a “matched filtering/correlating module” have to be a device with only one of those features? Ex.-2024,¶202.

A POSITA understands that a “module” in electronics is circuitry, not a device as Dr. Galton states. Ex.-2024,¶203.

Dr. Galton inexplicably and incorrectly excludes features from his definition which, as discussed in Section VI.A above, he admits are common features to a “matched filtering/correlating module.” Ex.-2024,¶¶204-206.

VII. THE ALLEGED PRIOR ART

A. U.S. Patent No. 6,600,726

Tayloe was filed October 15, 1998.

Consistent with the direction of the industry in the late 1990s, Tayloe discloses a voltage sampling system for direct down-converting an input signal. Because Tayloe is a voltage sampling system, Tayloe does not transfer energy. Ex.-2024,¶¶208-210.

All discussion in Tayloe refers to voltage. *See e.g.*, TI-1004, Abstract; 2:28-42; 3:40-56; 4:2-4, 46-57; 5:37 46. There is no mention of “energy,” “current,” or “power.” And a POSITA understands that all of the concepts taught in Tayloe relate to the use of voltage and voltage sampling to perform down-conversion of an input signal. A POSITA does not understand that Tayloe discloses, teaches, or suggests the use of energy or energy sampling to perform down conversion of an input signal. Ex.-2024, ¶¶211-212.

The “Background of the Invention” section of Tayloe discusses direct down-conversion of RF signals and the problem associated with existing solutions. TI-1004, Figures 1, 2; 1:10-45. Tayloe proposes a solution that purportedly solves the problem. Ex.-2024, ¶213.

Tayloe discloses a product detector (part of a down-converter) for converting an RF signal to a baseband signal using a switch, which samples an RF signal (waveform) during periods of the RF signal. *Id.*, Abstract. “The samples are integrated over time to produce an average voltage” *Id.* The “average voltage” is the baseband (down-converted) signal. *Id.* Ex.-2024, ¶214.

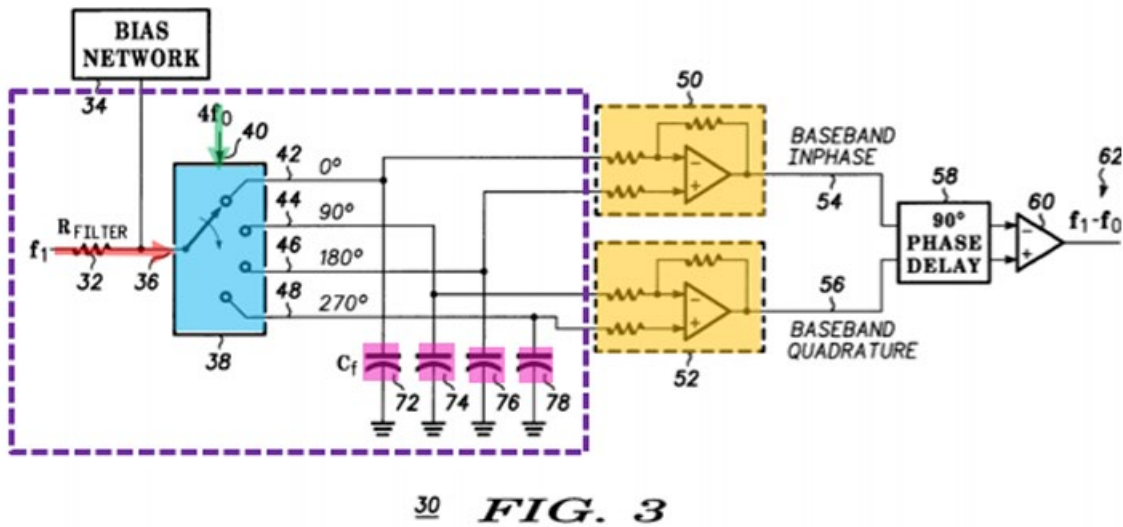


Figure 3 discloses a receiver 30 having a commutating switch 38 (blue), capacitors 72, 74, 76, 78 (pink), and summing amplifiers 50, 52 (orange). *Id.*, 2:6-12. Tayloe “product detector” or “Tayloe Product Detector” is shown in the purple dashed box. *Id.* at 3:1-4. Ex.-2024, ¶215.

A RF or IF signal f_1 (red arrow) is received at the resistor R_{FILTER} 32, which forms a filter when combined with the capacitors 72, 74, 76, 78. *Id.*, 2:13-15. Taylor touts this filter as being an important part of his work. TI-1004, 2:13-15, 3:21-39. Ex.-2024, ¶216.

The input signal f_1 (red arrow) is subsequently received by the commutating switch 38 (blue). *Id.*, 2:16-17. 9. The commutating switch 38 has one input 36 and four outputs 42, 44, 46, 48. *Id.*, 2:17-18. Upon receiving a control signal (green) at control input 40, the commutating switch 38 can move to one of four different positions: (1) time T1, the commutating switch 38 connects input 36 to output 42,

(2) time T2, the commutating switch 38 connects input 36 to output 44; (3) time T3, the commutating switch 38 connects input 36 to output 46, and (4) time T4, the commutating switch 38 connects input 36 to output 48. Id., 2:18-26. Ex.-2024, ¶217.

The input 36 is switched to each of the four outputs 42, 44, 46, 48 substantially once during each period of the input signal f_1 . Id., 2:24-26. The commutating switch 38 remains closed at each of the four outputs for 90 degrees or less of the input signal f_1 . Id., 3:27-31. Ex.-2024, ¶218.

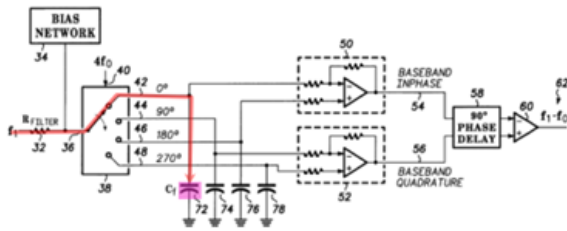


FIG. 3

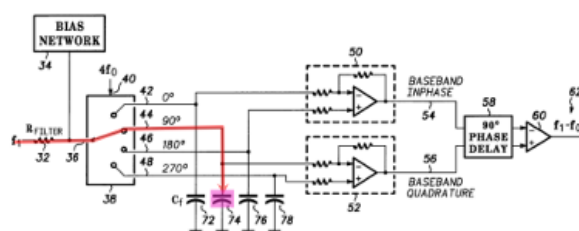


FIG. 3

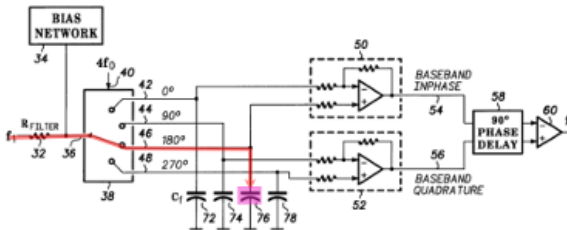


FIG. 3

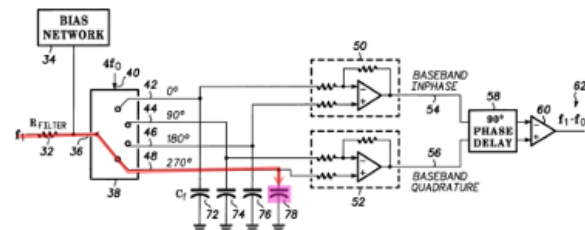
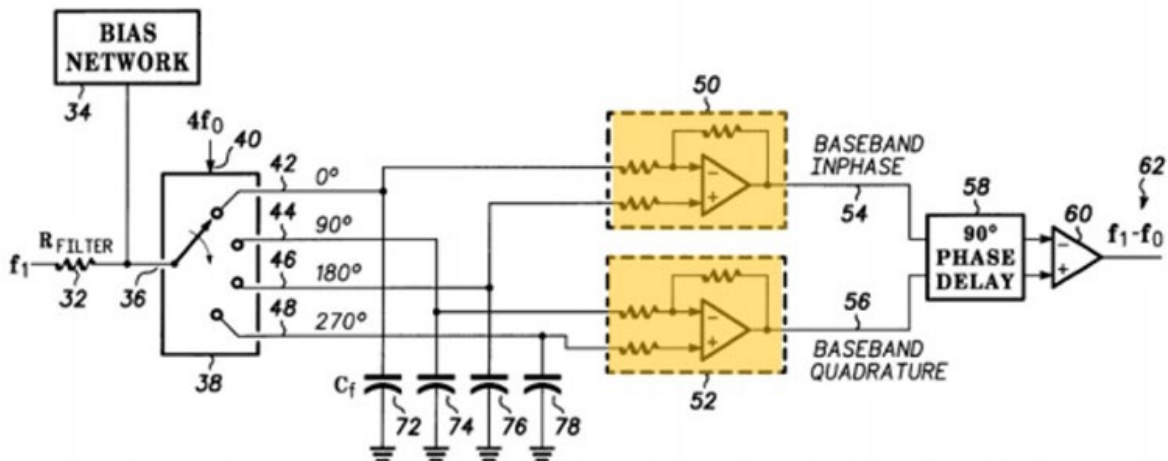


FIG. 3

“As commutating switch 38 cycles through the four outputs, capacitors 72-78 charge to voltage values substantially equal to the average value of the input signal during their respective quadrants.” Id., 2:38-41. As shown above, during the time that the commutating switch 38 connects input signal 36 to output 42 (top left), charge builds up on capacitor 72. When the commutating switch 38 connects input

signal 36 to output 44 (top right), charge builds up on capacitor 74. When the commutating switch 38 connects input signal 36 to output 46 (bottom left), charge builds up on capacitor 76. When the commutating switch 38 connects input signal 36 to output 48 (bottom right), charge builds up on capacitor 78. Id., 2:32-38. Ex.-2024, ¶219.

According to Tayloe, each of the capacitors operate as a separate integrator, which each integrate a separate quarter wave of the input signal f_1 . Id., 2:40-43. Ex.-2024, ¶220.



30 **FIG. 3**

As shown above in Figure 3, “the outputs of commutating switch 38 are input to summing amplifiers 50 and 52. Summing amplifier 50 differentially sums the 0 degree output and the 180 degree output, thereby producing baseband in-phase signal 54. Summing amplifier 52 differentially sums the 90 degree output and the

270 degree output, thereby producing baseband quadrature signal 56.” Id., 56-61.

Ex.-2024,¶221.

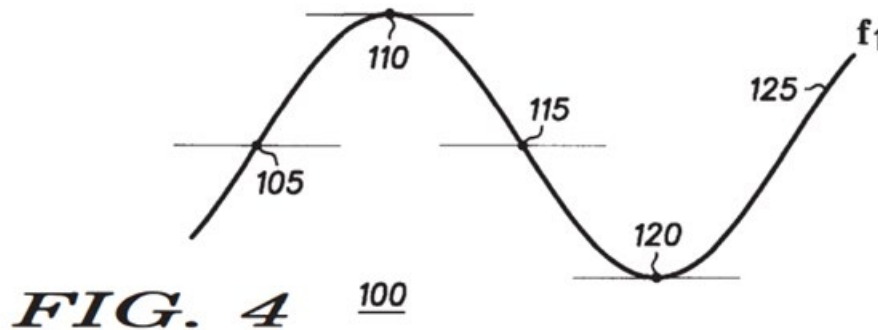
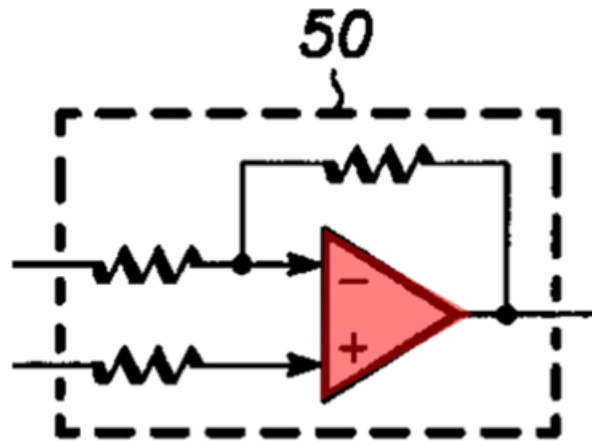


Figure 4 above illustrates how the system uses the input signal f_1 to determine the voltage to which to charge each capacitor. Figure 4 shows a waveform 100 including a signal 125 corresponding to input signal f_1 . Id. at 40-42. Ex.-2024,¶222.

As shown in Figure 4: “Point 105 represents the voltage to which capacitor 72 (FIG. 3) charges. Likewise, point 110 represents the voltage to which capacitor 74 charges, point 115 represents the voltage to which capacitor 76 charges, and point 120 represents the voltage to which capacitor 78 charges.” Id., 3:43-48. Ex.-2024,¶223.

Outputs 42, 44, 46, 48 represent average values of the input signal f_1 during quarter waves of a period. Id., 2:45-54. The points 105, 110, 115, 120 in Figure 4 represent the average value of voltage at 0° , 90° , 180° , 270° , respectively, of the input signal f_1 . Thus, the capacitors 72, 74, 76, 78 are charging to the average voltage as shown by points 105, 110, 115, 120, respectively. Ex.-2024,¶224.



As shown above in the excerpt from Figure 3, Tayloe discloses an op-amp (red triangle). Ex.-2024, ¶225.

A POSITA understands that the “+” and “-” inputs are connected to the gates of FETs. Ex.-2034, 72:9-73:6, 127:4-19. A POSITA understand that this results in very high impedance/high resistance. Dr. Galton admits this. Id., 72:14-73:6, 85:1-7 (“when you look into the -- in a typical op amp that you build in a CMOS process ... the inputs feeding into the gates of MOSFETs is true. And *gates of MOSFETs* are almost purely capacitive, meaning they’ve got an *exceedingly high resistive component*.”). Ex.-2024, ¶226.

A POSITA understands that if one input is high impedance/resistance, the other input must also be high impedance/resistance. As shown above, there is no feedback loop around the lower portion of the amplifiers 50, 52. The input goes into the gate of a FET which would be very high impedance/resistance. Thus, the “+”

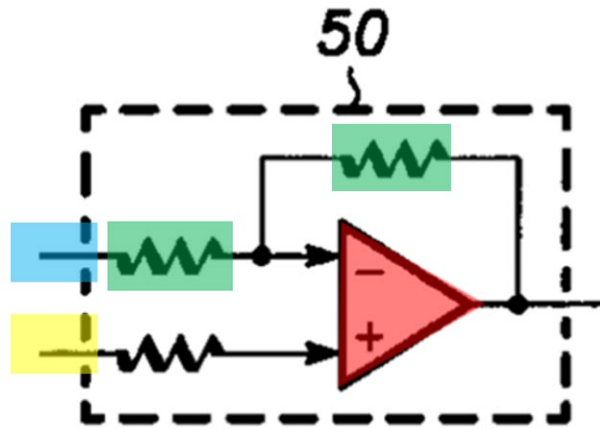
input will be high impedance/resistance. Dr. Galton admits this. Ex.-2034, 122:18-123:10, 126:7-127:1. The “+” input cannot be low impedance because there is no circuitry shown in Tayloe that would be able to compensate for the fact that, as shown, it has a high impedance. Therefore, because the “+” input is high impedance/resistance, the “-” input must also be high impedance/resistance. Ex.-2024, ¶227.

Another reason why the “-” input must be high impedance/resistance is because a POSITA understands that there cannot be a significant mismatch between the resistance/impedance of the “+” and “-” input. A POSITA understands that the “+” input would have a very high resistance/impedance – e.g., millions of ohms.¹² Dr. Galton's assertion that the input resistance of 50 and 52 would have a very low resistance (kilo-ohms or less) cannot be correct. TI-1003, ¶82. Ex.-2024, ¶228.

This is because the input resistance for both inputs of amplifier 50 (and for both inputs of amplifier 52) would need to be matched or nearly matched to each other so as to preserve the balance of the 0 and 180 degrees capacitors and the

¹² The most common op-amp at the time of the patent and Tayloe was the 741 Series op-amp, which had a high input resistance of typically 2,000,000 ohms. Ex.-2009; See Ex.-2004, 125:15-126:6. Notably, the '551 patent uses a 1 meg ohm resistor in Figure 78B as the load, which it identifies as a high impedance load.

balance of the 90 and 270 degree capacitors. As discussed above, the “+” input is extremely high impedance (e.g., 2 meg ohm) and, thus, the impedance looking into the resistor of 50, 52 connected to the “+” input must also be extremely high impedance (e.g., 2 meg ohm). Therefore, to keep the inputs of 50 or 52 balanced, the input resistance of the resistor connected to the “–” input must also be very high impedance. Ex.-2024, ¶228.



As shown above, the input resistance of the yellow input must be matched with the input resistance of the blue input. Because the input resistance of the yellow input will be very high (the input is connected to the “+” input which is very high impedance), the input resistance of the blue input must also be very high. Thus, resistors (green) must be very high resistance/high impedance. If the input impedances of blue/yellow do not match, the voltage measurements will not be symmetric and an error will occur in the voltage measurements. Accordingly, charge will be held in the capacitors of Tayloe and there will be no current or energy flowing towards 50 or 52 to form a down-converted signal. Ex.-2024, ¶229.

The “+” and “-” inputs cannot be substantially mismatched. Dr. Galton admitted that an op amp circuit would never be built with such a significant mismatch (it “literally would never happen”), these circuits are built as “symmetrical as possible,” and he has “never” purposefully designed an op amp circuit that had a significant mismatched impedance/resistance at its inputs. Ex.-2034, 82:17-86:5, 87:5-88:6, 92:22-93:16, 96:11-21, 97:20-100:21, 101:2-20. Ex.-2024, ¶230.

A summing circuit using an operational amplifier is predicated on the two inputs “+” and “-” being matched. If the two inputs were not being matched, the operation of the circuit would not function as designed. In analyzing an operational-amplifier feedback circuit, a POSITA would know to use the properties of high gain and high input impedance to establish a virtual short between the amplifier input terminals. This means that the voltage between the input terminals is essentially zero, while no current flows in them. Accordingly, Tayloe’s circuit would not work as described. Ex.-2024, ¶231.

Dr. Galton asserts that at higher frequency, impedance is lower; and low frequencies, impedance is higher. Ex.-2034, 116:21-118:9, 126:7-127:1. Tayloe specifically discloses using a frequency of 1kHz centered at 7MHz. TI-1004. This is a low frequency. Thus, under Dr. Galton’s own logic, that Tayloe uses a low frequency input further supports that the “+” input of the op amp is high impedance. Ex.-2024, ¶232.

Given the above, a POSITA would understand that both “+” and “-” inputs of Tayloe’s op-amp present high impedance loads. Ex.-2024, ¶¶233-234.

As the charge is being held, the system determines the voltage across the capacitor (i.e., the voltage level). At the next sampling interval, the voltage on the capacitor will change to the next average voltage value. Using multiple voltage readings, the system derives a baseband signal. Ex.-2024, ¶235.

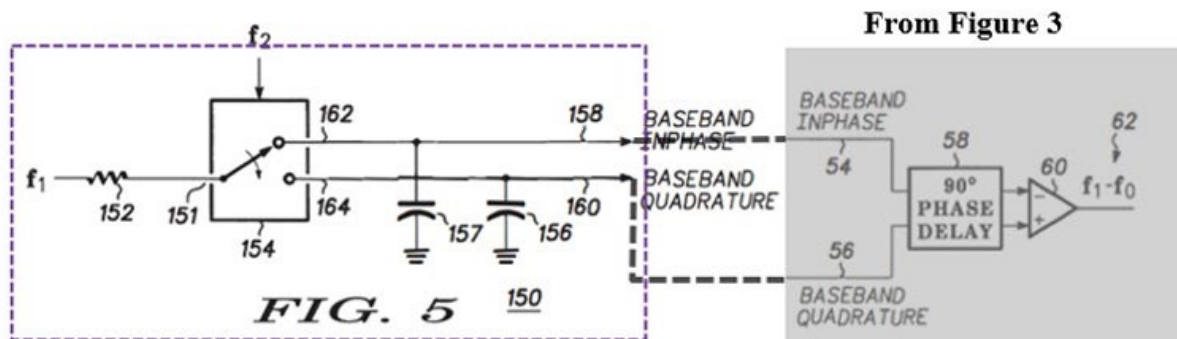
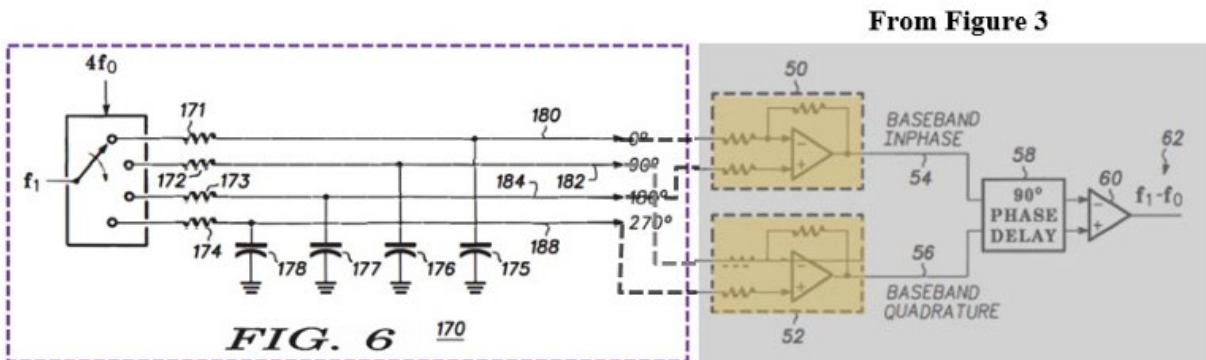


Figure 5 of Tayloe discloses an alternative embodiment of a product detector 150 (purple dashed box). TI-1004, 4:9-15. According to Tayloe, “[p]roduct detector 150 can be substituted into direct conversion receiver 30 (FIG. 3)” (id. at 4:42-44) and the only difference between Figure 3 and Figure 5 is that Figure 5 only has two outputs. Id. at 4:13-15. The circuit of Figure 5 works the same as the circuit of Figure 3 with regards to holding the average voltages on the capacitors and the analysis of Figure 3 above would apply to Figure 5. Tayloe does not disclose any load in Figure 5, which a POSITA would understand because Tayloe is a voltage sampling system. A POSITA would understand that the baseband in quadrature would be recombined

as illustrated in Figure 3, which only provides a phase delay (and infinite impedance) on the output of Figure 5. Based on the above, Figure 5 of Tayloe is operating as a voltage sampling system, not as an energy transfer (energy sampling) system. Ex.-2024, ¶236.



As shown above, Figure 6 of Tayloe discloses another alternative embodiment of a product detector 170 (purple dashed box) where the single resistor before the commutating switch of Figure 3 is replaced by four single resistors 171, 172, 173, 174 after the commutating switch (each capacitor has its own resistor). TI-1004, 4:46-49. As such, as shown above, a POSITA would understand that Figure 6 would be connected to the summing amplifier 50, 52 just like the product detector of Figure 3. Ex.-2024, ¶237.

In Figure 6, with the R_{FILTER} removed and replaced with separate resistors after the switch 38, the radio frequency source is connected directly to the commutating switch 38. But it makes no difference to the ideal operation of the Tayloe Product Detector whether R_{FILTER} is before the switch 38 as in Figure 3 or resistors 171, 172,

173, 174 are placed after the switch 38 and each resistor is equal to R_{FILTER} as in Figure 6. As such, the circuit of Figure 6 works the same as Figure 3 with regard to holding the average voltages on the capacitors 175, 176, 177, 178 and the analysis of Figure 3 above applies to Figure 6. Ex.-2024, ¶238.

Moreover, with regard to Figure 6, Tayloe clearly focuses on voltage and how voltage is controlled by the combination of the capacitor and resistor. TI-1004, 4:49-57. The statement that the voltage of the outputs are controlled by the capacitor and resistor means that the voltage across each capacitor is not affected by the circuitry to the right of the capacitor. This demonstrates that the summing amplifiers 50, 52 and/or other circuitry to the right of the capacitors 175, 176, 177, 178 is a high impedance load to each capacitor, which is a characteristic of a voltage sampling system. 39. In view of the foregoing, Figure 6 of Tayloe is operating as a voltage sampling system, not as an energy transfer (energy sampling) system. Ex.-2024, ¶239.

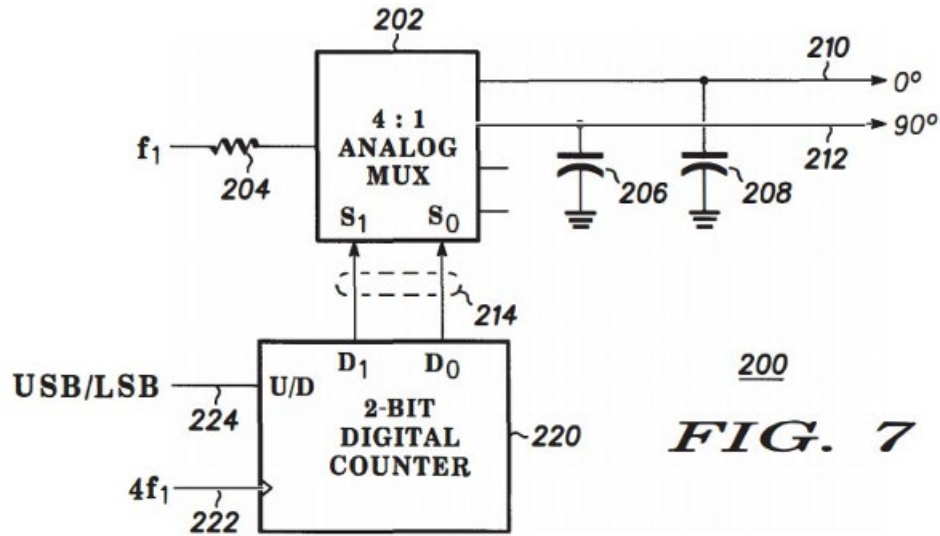


Figure 7 of Tayloe discloses another alternative embodiment of a product detector. TI-1004, 5:1-16. Moreover, a POSITA understands that if output 210, output 212, as well as 180 degree and 270 degree outputs are being used, Figure 7 would be connected to the summing amplifier 50, 52 just like the product detector of Figure 3. Ex.-2024, ¶¶240-241.

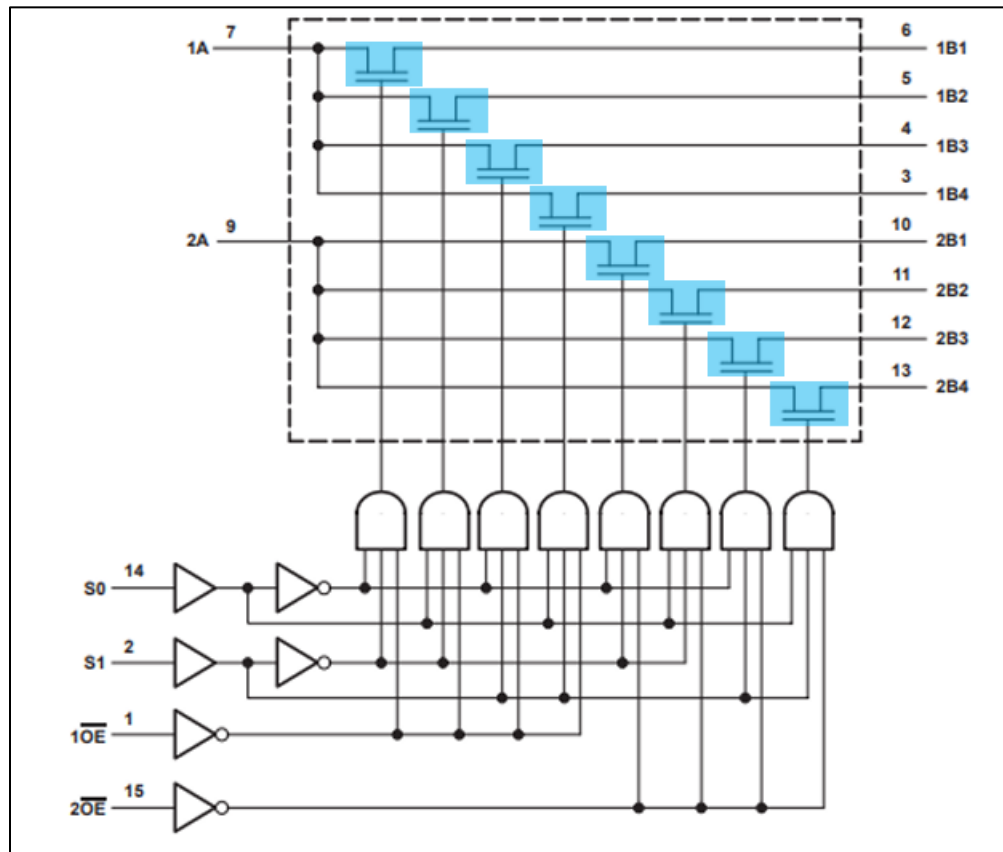
The circuit of Figure 7 works the same as Figures 3 and 5 (depending on how many outputs are used) with regard to holding the average voltages on the capacitors 206, 208. Thus, Figure 7 of Tayloe is operating as a voltage sampling system. Ex.-2024, ¶242.

Figure 7 of Tayloe is operating as a voltage sampling system, not as an energy transfer (energy sampling) system. Ex.-2024, ¶243.

B. Texas Instruments Datasheet

The TI Datasheet is the product specification for the TI SN74CBT3253. Texas Instruments relies on the TI Datasheet for its switch configuration. Ex.-2024, ¶244.

The TI Datasheet discloses a dual 1-of-4 high-speed TTL-compatible FET multiplexer/demultiplexer. Ex.-1005. Ex.-2024, ¶245.

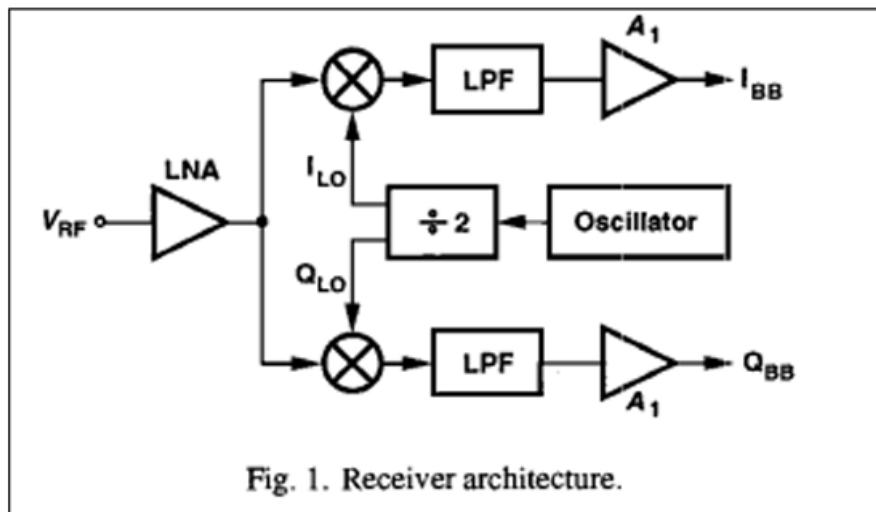


As shown above, the multiplexer/demultiplexer includes multiple FETs (blue below) which are used as switches. Ex.-2024, ¶246.

C. Razavi

Razavi is a paper entitled “A 900-MHz CMOS Direct Conversion Receiver.” TI-1017. Razavi’s mixer was a research project.

Razavi describes the design of a single-chip 900-MHz CMOS direct conversion receiver (DCR) fabricated in digital 0.6- μm technology. TI-1017, 113. A block diagram of a general DCR architecture is shown in Figure 1 (below). Dr. Razavi explains how he proposes modifying this circuit to create a different type of direct downconverter. Ex.-2024, ¶¶248-249.



As shown in Figure 1, the DCR consists of a low-noise amplifier (LNA), in-phase and quadrature mixers, low-pass filters (LPFs), and baseband amplifiers A_1 . This down-converter was already known at the time Razavi wrote his paper. The in-phase and quadrature-phase mixers are driven by local oscillator (LO) signals offset by 90-degrees. Razavi notes seeks to avoid the use of passive mixers. TI-1017, 113. Accordingly, Razavi discloses a DCR using active mixers. Ex.-2024, ¶250.

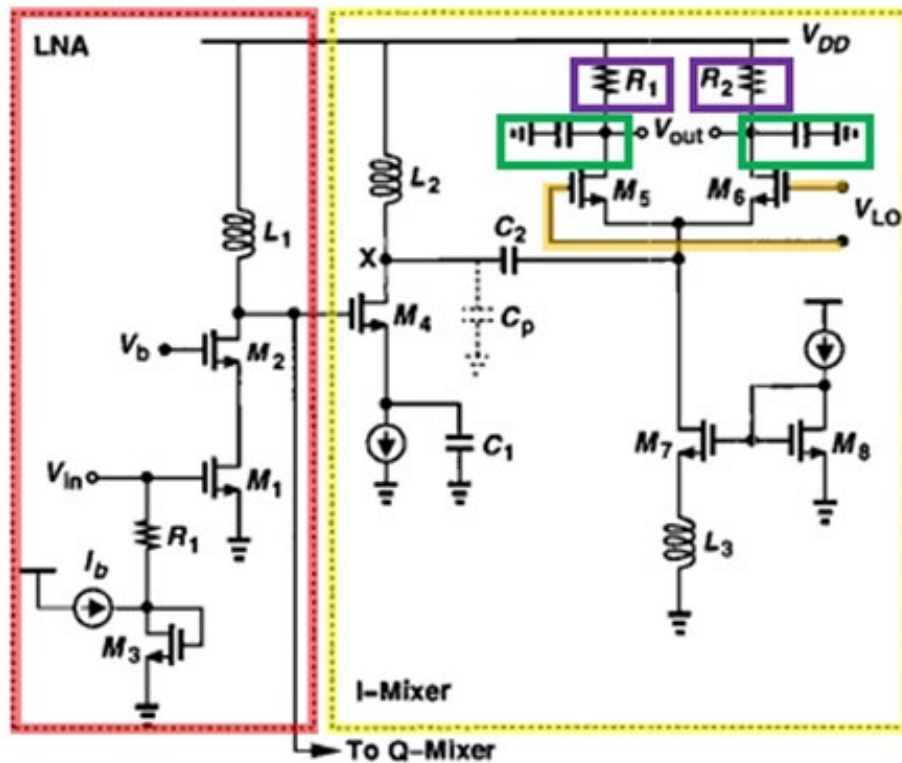


Fig. 2. LNA/mixer implementation.

Figure 2 from Razavi (above) illustrates the LNA (shown in the red box) and I mixer (shown in the yellow box). As shown above, the RF signal passes through the LNA and is subsequently received by the I-mixer. The mixer is a single-balanced mixer. TI-1017, 113. A POSITA understands that a single-balanced topology means that the local oscillator is differential, and the RF input signal is single-ended. Ex.-2024, ¶251.

Razavi characterizes transistors M5 and M6 as a “switching pair,” because they commute the signal current. Transistors M5 and M6 are NMOS FETS. Ex.-2034, 203:9-12. The RF input signal is applied to the common node of the source

terminals of M5/M6, and drain node of M7. The drain terminals of M5/M6 are connected to VDD through resistors R_1/R_2 . Id., 214:4-7. Ex.-2024, ¶252.

A POSITA recognizes that transistors M5/M6 form a well-known circuit topology – a differential pair. A POSITA also recognizes that M5 and M6 pass a DC current that flows from VDD to ground and is controlled by transistor M7. Ex.-2024, ¶253.

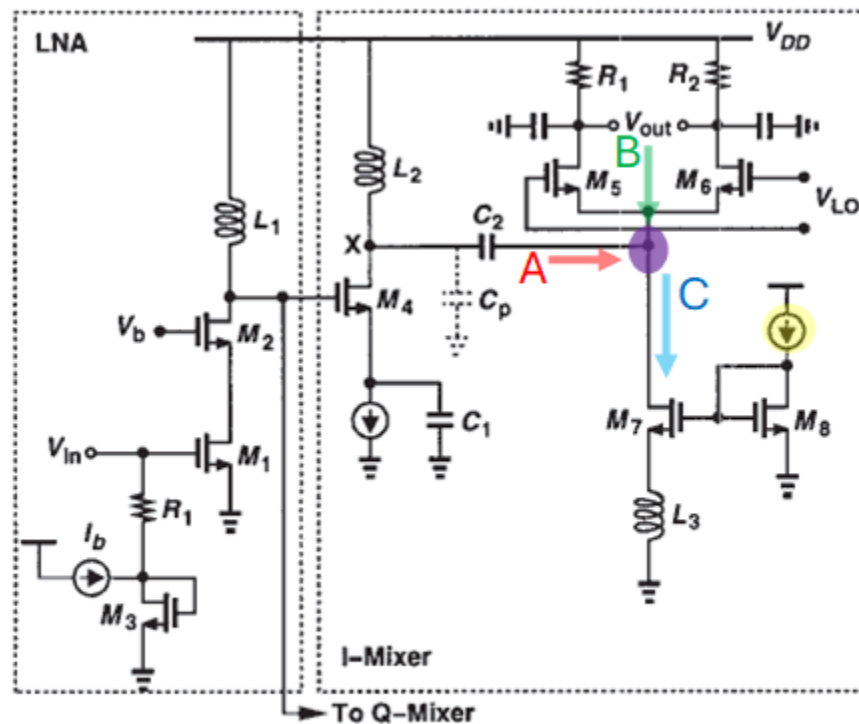
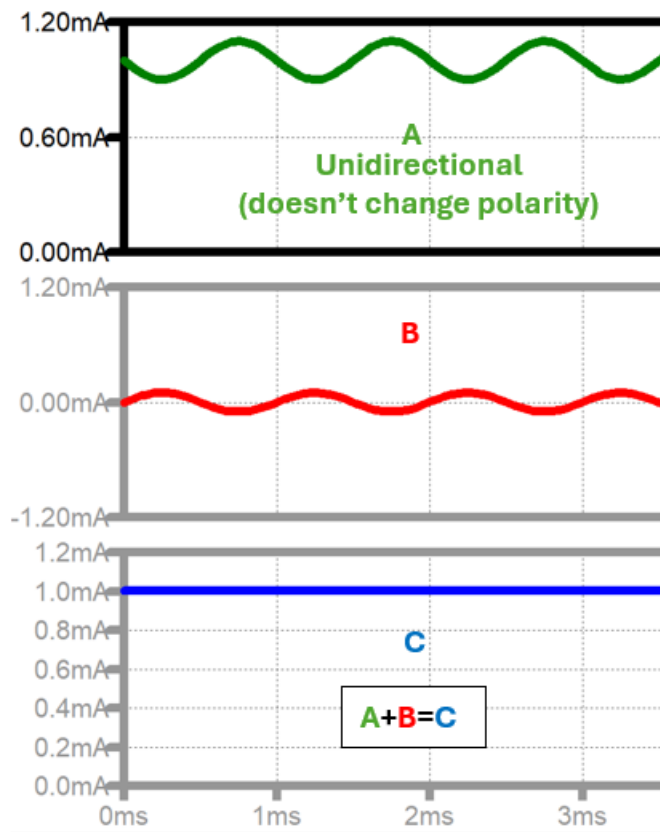


Fig. 2. LNA/mixer implementation.

A POSITA would recognize from fundamental circuit theory that the current flowing through M7 must be direct current (DC). A POSITA would understand that a DC current is mirrored from M8 to M7, as shown by the DC current symbol

(yellow). Thus, a POSITA would recognize that the current in M7 is also a DC current. Ex.-2024,¶255.

At the node (purple), current A (red arrow) represents the RF input signal flowing into the node. Current C (blue arrow) represents current flowing out of the node through M7. Current B (green arrow) is determined as the difference between current C and current A. Ex.-2024,¶¶255-257.



As shown above, current B—the total current flowing through the differential pair M5 and M6—is always a positive number. Because current B is always positive, current is always flowing from VDD to M7. Current B increases or decreases such

that when combined with current A, it forms a constant current that flows through M7. Ex.-2024, ¶258.

M5 and M6 operate by steering current from VDD through either R_1 and M5 or R_2 and M6, depending on the local oscillator (LO) signal applied to their gates. As the LO signal varies, it modulates the gate voltages of M5 and M6. This affects the flow of current through M5 and M6. When the gate voltage of M5 is substantially greater than that of M6, current flows from VDD, through R_1 and M5, and down to M7. When the gate voltage of M6 is substantially greater than that of M5, current flows from VDD, through R_2 and M6, and down to M7. Therefore, M5 and M6 simply serve as a current-steering mechanism that routes current from VDD through either R_1 or R_2 before reaching M7. Ex.-2024, ¶259.

Further, Razavi states “[t]o achieve a high conversion gain, M5 and M6 must remain in saturation.” Ex.-1017, 113. A POSITA understands that for an NMOS transistor to remain in saturation, the drain-to-source voltage must be positive, meaning current can only flow from the drain to the source. See Section III.B.2. Therefore, a POSITA understands that, in Razavi’s NMOS transistors, current flows from the drain to the source, not the other way.¹³ Current cannot flow from the RF

¹³ Dr. Galton stated that current can move in both directions in an NMOS transistor when used as a transconductor. Ex.-2004, 245:5-15. However, he later

input signal upward through the NMOS transistors from source to drain. Ex.-2024,¶260.

Further, a POSITA understands that, in Razavi, current flows from VDD downwards towards M5 and M6 from a higher to lower potential. Ex.-2034, 152:19-22, 164:13-166:7, 203:13-19. Current does not flow upwards from M5 or M6 to VDD. Ex.-2024,¶261.

Though M5 and M6 can modulate the amount of current flowing downward from VDD (Ex.-2034, 167:13-22), they do not reverse the current flow direction. No current flows upward through M5 or M6 toward VDD. Thus, the input signal cannot propagate from the input (source of M5 and M6) to the capacitors or resistors R_1/R_2 . Ex.-2024,¶262.

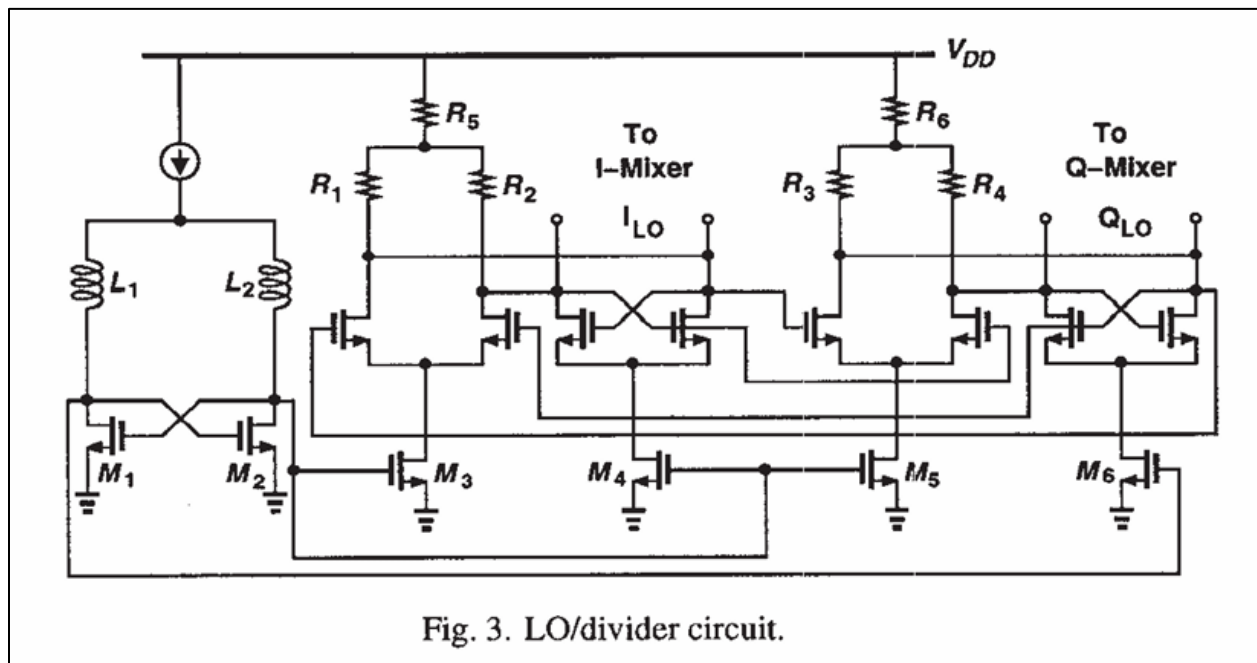
Dr. Galton attempts to distinguish between absolute current and signal current (“signal component”) and asserts that signal current flows upward in the circuit. Ex.-2034, 152:19-153:14, 165:21-167:12. Dr. Galton is wrong. Current through M5 and

admitted that M5 and M6 are not used as transconductors. Id., 251:13-15. Thus, in Razavi, current through M5 and M6 can only flow down, not up. Razavi states that the transistors operate in the saturation region, which is distinct from transconductance-mode operation. Ex.-1017, 113; Section III.B.2. Ex.-2024,n.12.

M6 is affected by the RF input signal, but the current remains unidirectional—always flowing downward to ground. There is never a situation where current from the RF input signal flows from the source of M5 and M6 toward VDD, as Dr. Galton suggests. Ex.-2024,¶263.

Transistors M5/M6 in Figure 2 are driven by a differential LO signal. Ex.-2024,¶¶264-265.

A POSITA understands that Razavi uses a 50% duty cycle LO because the oscillator is symmetric. Ex.-2024,¶266.



A POSITA would recognize that inductors L1 and L2 of Figure 3 produce a sinusoidal output. Despite Dr. Galton's assertion that the LO signal in Razavi's circuit is a square wave, he provides no support. At high frequencies, such as 900MHz in Razavi, most local oscillators are sinusoidal. Ex.-2024,¶267.

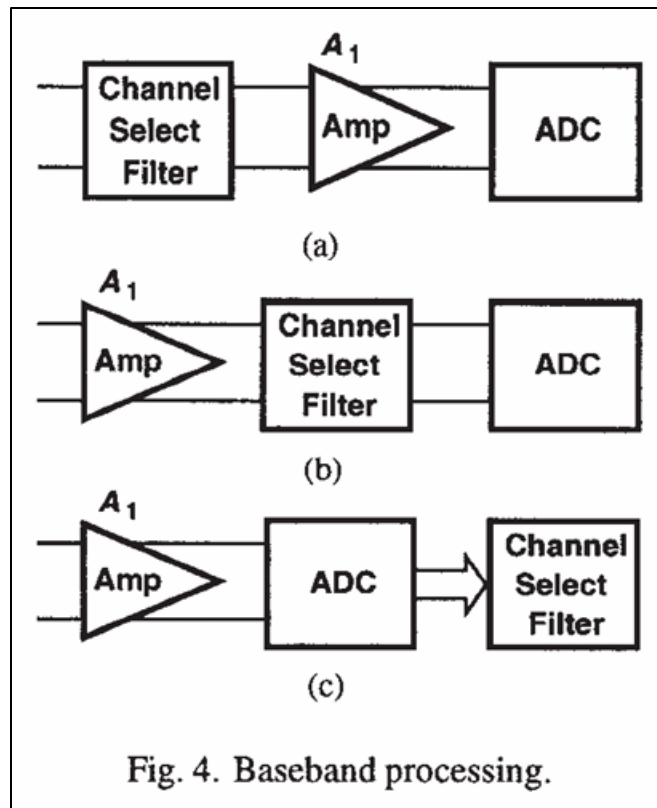
In Razavi, the capacitors (green boxes above) are solely used for filtering. The mixers (non-sampling mixers) in Razavi's circuit inherently produce high-frequency components and "[t]he output nodes of the mixer [(V_{out})] are loaded with on-chip capacitors to suppress high-frequency components." TI-1017, 113. In Razavi's configuration, the capacitors do not store and/or integrate energy from the RF input signal to form the down-converted signal. In Razavi's configuration, no energy from the RF input signal is integrated/accumulated in the capacitors, because current only flows downward from VDD to M5/M6. Ex.-2024, ¶268.

In Razavi, the capacitors are connected to resistors R1 and R2 (purple boxes above). Razavi notes that to achieve high conversion gain, in addition to the transistors being in saturation, "and more importantly, the voltage drop across R1 and R2 must be maximized." TI-1017, 113. A POSITA would understand that the voltage drop across any resistor depends upon the magnitude of the resistance of that resistor. The higher the magnitude of resistance, the greater the voltage drop across the resistor i.e., resistors R₁ and R₂ need to be as high resistance/impedance as possible. Ex.-2024, ¶269.

The down-converted signal in Razavi is a voltage and not current (i.e. energy). Figure 2 of Razavi identifies the output of the mixer as a voltage, i.e. V_{out}. Dr. Galton admits this. Ex.-2034, 161:6-16. Thus, energy from the input signal is not forming the down-converted signal. Ex.-2024, ¶270.

Razavi specifically teaches to use the configurations of Figures 4(b)/4(c). The output of the mixer (V_{out} in Figure 2) is connected directly to the input of baseband amplifiers. The baseband amplifiers have high input impedance because their inputs are directly into the gates of MOSFETs. Thus, V_{out} is a voltage and no energy is transferred from capacitors in Figure 2. Ex.-2024, ¶271.

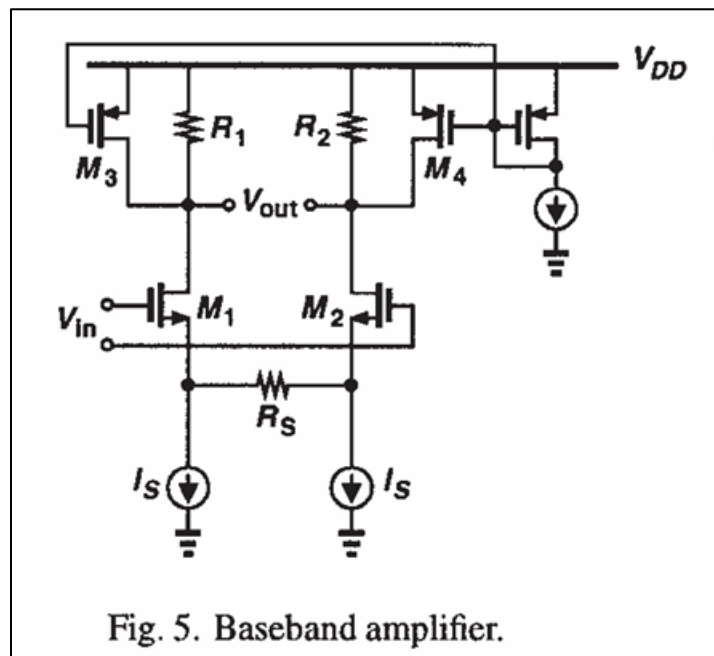
Figure 4, below, shows three permutations considered by Dr. Razavi for the circuit following the mixer. Ex.-2024, ¶272.



Razavi specifically teaches not to use the permutation shown in Figure 4(a). TI-1017, 113. Razavi criticizes this permutation because “the low-pass filter design entails severe noise-linearity-power tradeoffs.” Id. Notably, Razavi specifies that

“[t]he present design is *intended for permutations in Figs. 4(b) and (c).*” Id. Ex.-2024,¶273.

In the configurations of Figures 4(b)/4(c), the mixer stage is followed by a baseband amplifier A1. Dr. Galton admits this. Ex.-2034, 201:5-11. The baseband amplifier is shown in Figure 5 (below). Ex.-2024,¶274.

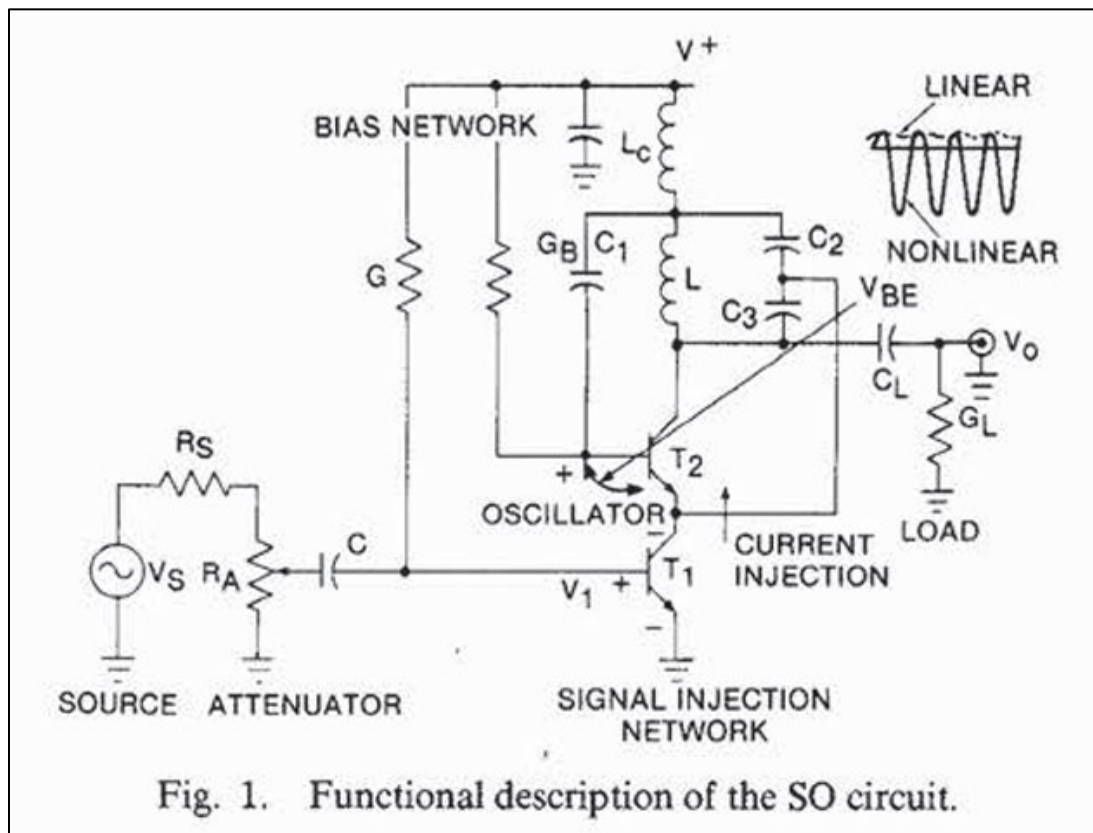


The input of the amplifier (V_{in}) is applied to the gates of transistors M1/M2. A POSITA understands that the gate of a FET presents a high input impedance and does not draw current. See Ex.-2034, 202:17-203:5. Thus, a POSITA understands that the amplifier A1 is a high impedance load. Ex.-2034, 117:10-12; 118:5-7. And no current or energy is transferred from the mixer to the baseband amplifier – whether from the capacitors or VDD in Figure 2. Ex.-2024,¶275.

D. Uzunoglu

Uzunoglu is a paper entitled “The Synchronous Oscillator: A Synchronization and Tracking Network.”

As shown below in Figure 1, Uzunoglu discloses a synchronous oscillator (SO) circuit. Ex.-2024, ¶277.



Uzunoglu explains that the SO is “a free-running oscillator which oscillates at its natural frequency in the absence of an externally applied signal. In the presence of a signal the oscillator synchronizes with and tracks the input waveform with an acquisition time inversely proportional to the tracking bandwidth. TI-1026, Abstract. Ex.-2024, ¶278.

VIII. VALIDITY OF THE '177 PATENT

A. Ground 1: Tayloe in view of the TI Datasheet

Claim 14 of the '177 patent is not obvious over Tayloe in combination with the TI Datasheet. Ex.-2024,¶279.

1. Tayloe is not prior art.

Tayloe was filed on October 15, 1998. As discussed in Section V.C, claim 14 of the '177 patent was conceived of and reduced to practice months before the filing of Tayloe. Accordingly, Tayloe is not prior art. Thus, Tayloe alone or when combined with the TI Datasheet cannot invalidate claim 14 of the '177 patent. Ex.-2024,¶280.

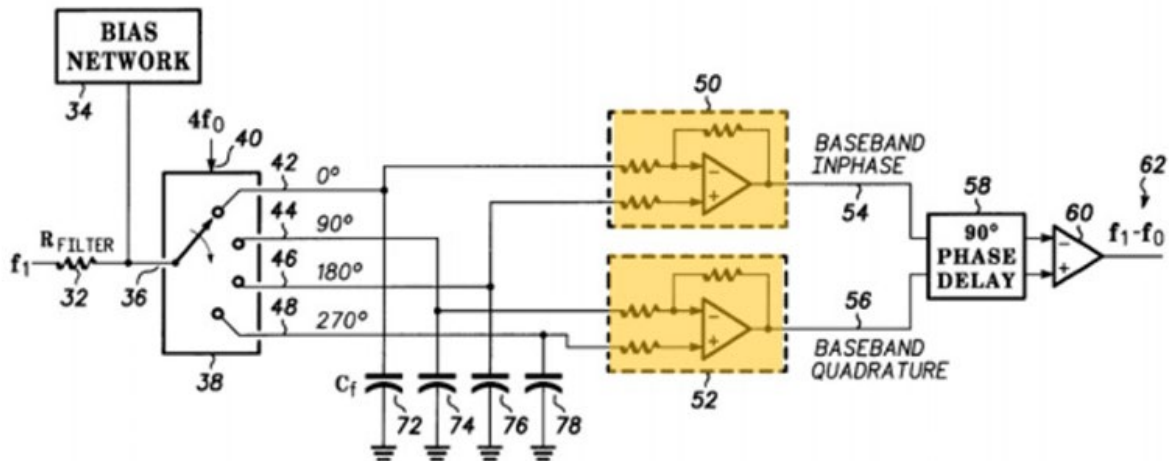
2. Tayloe/TI Datasheet does not disclose, teach, or suggest a “matched filtering/correlating module.”

Claim 14 recites a first and second “matched filtering/correlating module.”

A “matched filtering/correlating module” requires that “energy of the input signal is integrated and transferred to a load to form a down-converted signal.”

Tayloe does not disclose, teach or suggest this. Ex.-2024,¶¶282-283.

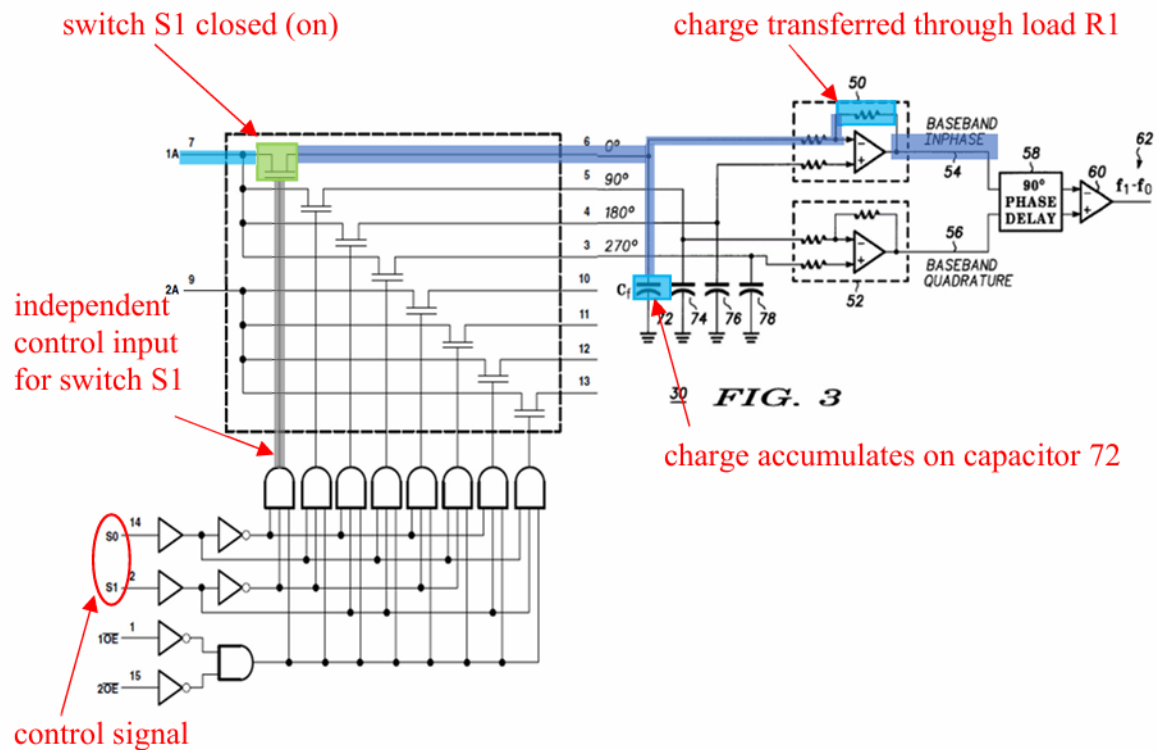
Tayloe is a voltage sampling system and amplifiers 50, 52 (orange below) are high impedance loads. Section VII.A. Thus, a POSITA recognizes that the capacitors in Tayloe hold charge (not discharge) so that an accurate reading of voltage can be taken. Ex.-2024,¶284.

30 **FIG. 3**

A POSITA understands that Tayloe determines derives the baseband signal from multiple voltage readings. Ex.-2024,¶285.

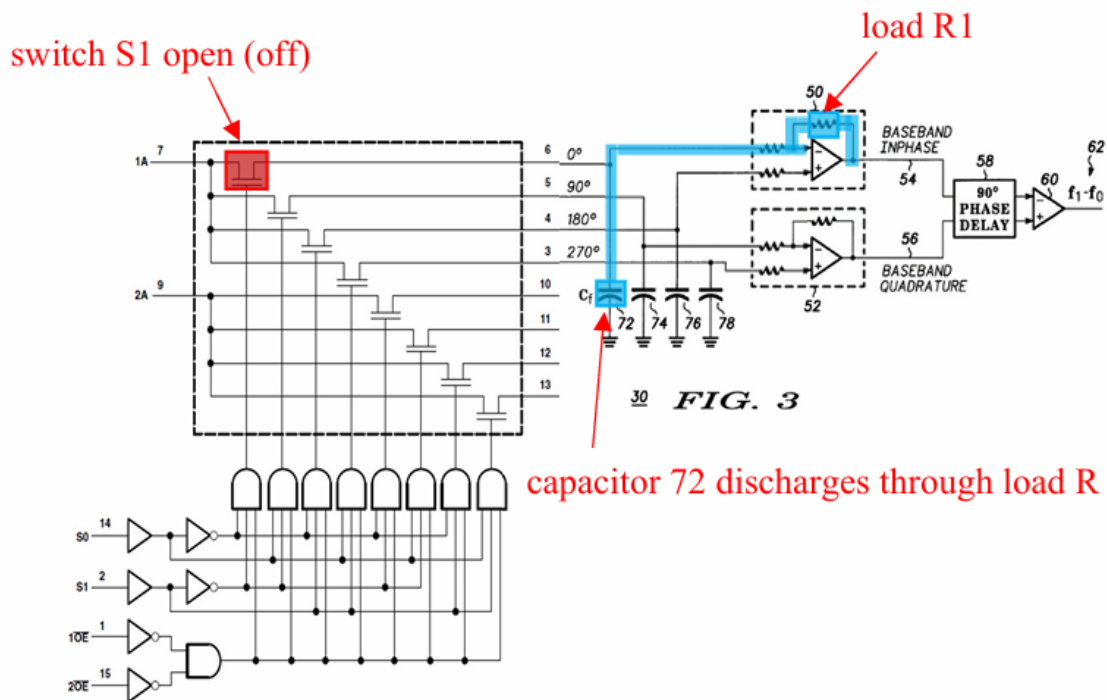
Because Tayloe is designed to hold charge, the capacitors do not transfer energy to amplifiers 50, 52 as Petitioner alleges. None of the capacitors discharge towards amplifiers 50, 52. There is no current or energy being transferred to a load (from the input signal or capacitors). As a result, no energy will form a first or second down-converted signal. Further, any appreciable current coming from a switch when the switch is closed is directed to the capacitors, not the high-impedance load (inputs of amplifiers 50, 52). Ex.-2024,¶286.

As shown below, Dr. Galton alleges that, when the with S1 is closed, charge (dark blue line) from samples are transferred to a load R1 and charge accumulates at capacitor 72. Ex.-2024,¶287.

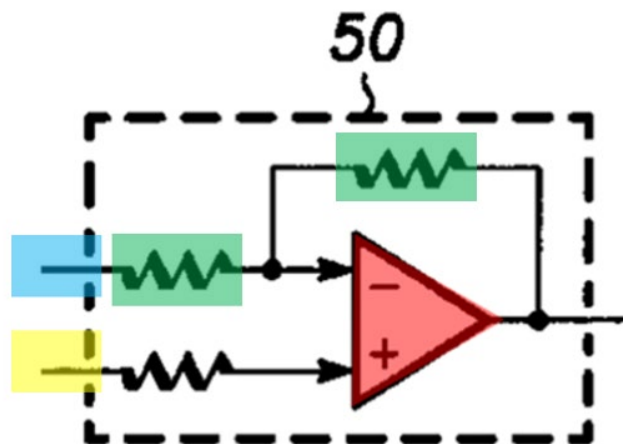


Ex.-1003, ¶118, 122, 123; *see also id.* ¶143 (discussing second matched filtering/correlating module).

As shown below, Dr. Galton also alleges that, when the with S1 is open, charge (light blue line) from capacitor 72 is discharged to a load R1. Ex.-2024, ¶288.



Dr. Galton misinterprets the operation of Tayloe's circuit. Ex.-2024, ¶289.



As shown above, the "+" input of the op-amp (red triangle) has a very high input resistance. See Section VII.A. Because the yellow input is directly connected to the "+" input of the op-amp, the yellow input also exhibits a very high resistance.

The resistor next to the yellow input only increases the resistance and further prevents current flow. Ex.-2024,¶290.

As discussed in Section VII.A above with regard to the diagram above, both the yellow and blue inputs to amplifiers 50,52 exhibit very high resistance/impedance. This high resistance/impedance prevents the flow of current/charge to the amplifiers 50, 52. As such, no charge or current (and, thus, no energy) (1) transfers from any Tayloe switch to a load (or to the inputs of the amplifier 50, 52) while a switch is closed; (2) discharges from any Tayloe capacitor toward the amplifier inputs while the switch is open; or (3) discharges through any resistor in the amplifier 50, 52 (including R1 as identified by Dr. Galton) while a switch is open. Ex.-2024,¶291.

As discussed in Section VII.A, Figure 5 would be connected with phase delay 58 and amplifier 60 of Figure 3. The “+” and “-” inputs of amplifier 60 are high impedance for the same reason that the “+” input of amplifiers 50, 52 are high impedance. Thus, no charge or current (and, thus, no energy) or sample (1) transfers from any Tayloe switch to a load (or to the inputs of the amplifier 60) while a switch is closed, (2) discharges from any Tayloe capacitor toward the inputs of the amplifier 60 while a switch is open, or (3) discharges through any part of amplifier 60 while a switch is open. Ex.-2024,¶292.

Figures 6 and 7 would be connected to amplifiers 50, 52 of Figure 3. Thus, the analysis above of Figure 3 applies to Figures 6 and 7 as well. Ex.-2024, ¶¶293-294.

Thus, Tayloe (whether alone or in combination with the TI Datasheet) does not disclose, teach, or suggest a “matched filtering/correlating module,” as claimed. Ex.-2024, ¶295.

3. Tayloe/TI Datasheet does not disclose, teach, or suggest a “matched filtering/correlating module” under the Florida Court’s construction.

Under the Florida Court’s construction, Tayloe fails to disclose, teach, or suggest a “matched filtering/correlating module.” Ex.-2024, ¶297.

Tayloe/TI Datasheet does not disclose, teach, or suggest circuitry for down-converting an input signal such that “samples, having non-negligible available energy... are... transferred to a load while the switch is closed and discharged through the load while the switch is open” for the same reason set forth in Section VIII.A.2. As discussed in Section VIII.A.2 above, no current, charge, or energy is transferred from the RF input signal to amplifiers 50, 52, or 60 in Tayloe. Ex.-2024, ¶298.

Tayloe does not disclose, teach, or suggest “transferring available real power from the modulated RF carrier signal to the load and producing a downconverted signal.” Dr. Galton asserts that real power is being transferred from Tayloe’s

capacitors. Ex.-1003, ¶¶126-127. But, as discussed in Section VIII.A.2 above, no current, charge, or energy (and, thus, no power) is transferred from the RF input signal to amplifiers 50, 52, or 60 in Tayloe. Because the charge is retained within the capacitors rather than being transferred to a load, there is no transfer of available real power. Ex.-2024, ¶299.

B. Ground 2A: Razavi

Claim 14 of the '177 patent is not obvious in view Razavi. Ex.-2024, ¶300.

1. Razavi does not disclose, teach, or suggest a “matched filtering/correlating module.”

Claim 14 recites a first and second “matched filtering/correlating module.”

A “matched filtering/correlating module” requires “circuitry that samples an input signal at an aliasing rate.”

Razavi does not disclose, teach or suggest this. Ex.-2024, ¶290.

Petitioner/Dr. Galton rely on the mixer in Figure 2 of Razavi as the claimed “matched filtering/correlating module.” But the mixer in Razavi does not sample an input signal at an aliasing rate. Dr. Galton's explanation of how the mixer in Razavi works is incorrect. Ex.-2024, ¶305.

A POSITA understands that sampling means reducing a continuous-time signal to a discrete-time signal.¹⁴ Notably, as discussed in Sections III.B.11 and IV,

¹⁴ Dr. Galton provides no explanation as to what sampling actually means.

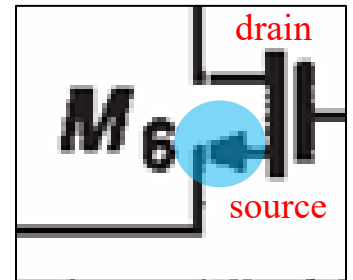
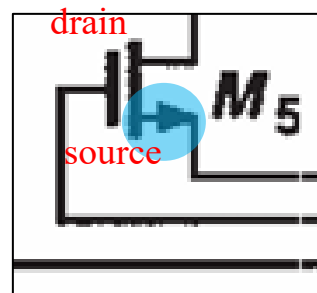
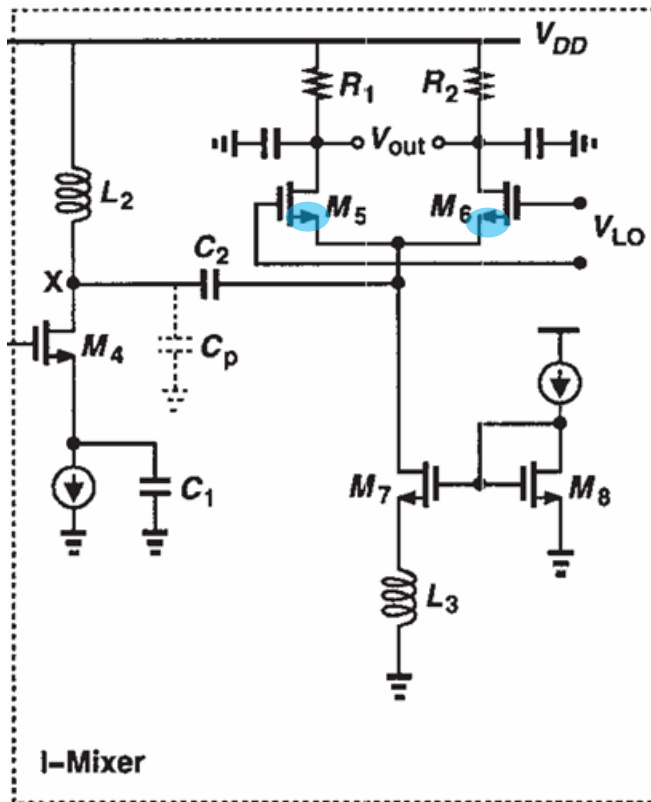
in all sampling systems (including Tayloe), there is a continuous current from the RF input signal at the input of a switch. When the switch is ON (closed), current of the RF input signal can pass through. When the switch is OFF (open), current cannot pass through. Turning the switch ON and OFF creates gaps in the RF signal current at the output of the switch. Thus, in a sampling system, the RF input signal must physically pass through a switching element in a way that breaks the continuous signal into discrete-time samples. Ex.-2024, ¶306.

Dr. Galton asserts that the mixer in Razavi performs sampling allegedly because the LO signal opens and closes transistors M5 and M6 at a rate of 900 MHz. TI-1003, ¶164. Dr. Galton's reasoning is wrong. Even assuming Dr. Galton is correct that the LO signal "opens" and "closes" transistors M5 and M6, simply turning transistors on and off does not constitute sampling. Dr. Galton does not explain how Razavi actually samples an input signal or any signal. Razavi does not do so. Ex.-2024, ¶307.

In order for the RF input signal of Razavi to be sampled, the RF input signal needs to go from a continuous-time signal to a discrete-time signal. But, as explained in Section VII.C above, Razavi does not work that way. The RF input signal does not (and cannot) physically pass through transistors M5 or M6. Because the RF input signal cannot physically reach the drain of transistors M5 and M6, it never appears

as a discrete-time signal at the output of the mixer. Ex.-2024, ¶308.

Dr. Galton admits that M5 and M6 are NMOS transistors that do not operate as transconductors. Ex.-2034, 203:9-12; 251:13-15. Instead, as explained in Section VII.C above, transistors M5 and M6 operate in saturation. A POSITA understands that in the configuration of Razavi, current can only flow through M5 to M6 in one direction —downward from drain to source. This unidirectional current flow is *opposite* to the direction needed for the RF input signal to pass through the transistors. Since the RF input signal cannot propagate through M5 or M6, it cannot be sampled. Ex.-2024, ¶309.



As shown Figure 2 above, the NMOS symbols (expanded above right) for M5

and M6 depict arrows indicating the direction of current flow—from the drain to the source. A POSITA understands that in saturation, current only flows out of the source as shown by the blue arrows. Ex.-2024, ¶310.

The RF input signal (AC current in capacitor C2) is applied to the common node of the source terminals of M5 and M6, and the drain terminal of M7. A POSITA understands that the current from the RF input signal always flows downward toward M7, never passing through M5 or M6. Thus, RF input signal remains a continuous-time signal throughout the circuit. Nothing in Razavi's mixer changes this fact. Ex.-2024, ¶311.

Even assuming that transistors M5 and M6 are switches that open and close, this would not change the fact that no current from the RF input signal passes through M5 or M6 from the source to the drain. Thus, M5 and M6 cannot sample the input signal. Accordingly, Razavi does not sample an input signal. Ex.-2024, ¶312.

The fact that Razavi's mixer does not sample an RF input signal would also be known to a POSITA based on how Razavi's mixer actually works. Ex.-2024, ¶313.

A POSITA understands that current flows from a higher potential to a lower potential. Dr. Galton admits this. Ex.-2034, 152:19-22. In Figure 2 of Razavi (shown

below), VDD¹⁵ is the highest potential in the circuit. Consequently, current flows downward from VDD, through resistors R₁ and R₂, transistors M5, M6, and M7, and ultimately to ground. Ex.-2024, ¶314.

Even assuming transistors M5/M6 turn ON and OFF, the only direction of current flow remains downward from VDD to ground. Dr. Galton admits this. *Id.*, 164:13-21. Ex.-2024, ¶315.

The below diagrams show how current flows in two scenarios: (1) when M5 is closed and M6 is open, and (2) when M5 is open and M6 is closed. Ex.-2024, ¶316.

¹⁵ The difference between VDD and ground is the power supply voltage. Ex.-2004, 156:12-15.

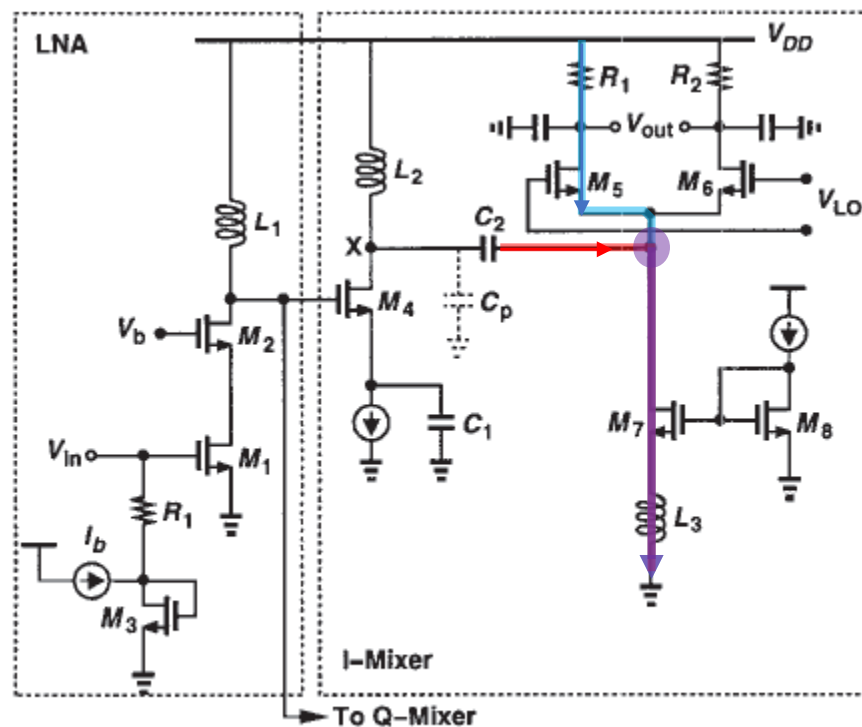
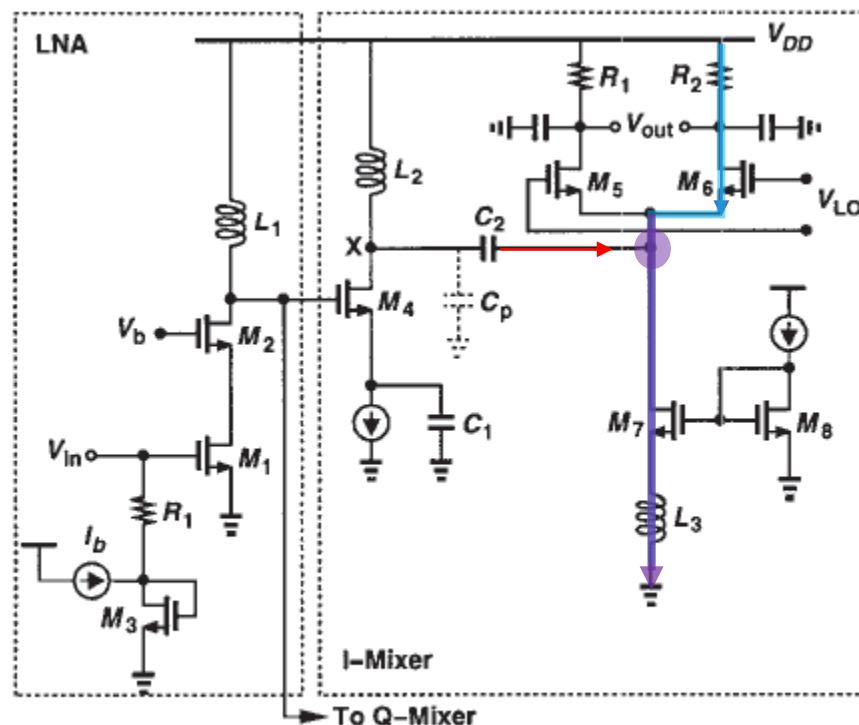


Fig. 2. LNA/mixer implementation.

As shown above, if transistor M5 is closed and transistor M6 is open, current from VDD (blue arrow) flows downward through R_1 and M5 to the common node (purple). The RF input signal current (red arrow) flows from capacitor C2 to the same common node (purple). These currents combine and flow through M7 toward ground (purple arrow). Ex.-2024, ¶317.



ground (purple arrow). Ex.-2024, ¶318.

There is no sampling of the RF input signal. Ex.-2024, ¶319.

amount of current flowing downward from VDD. Ex.-2034, 167:16-22. When the

RF signal is stronger, more current is supplied through C2, reducing the amount of current that must come from VDD. Conversely, when the RF signal is weaker, the current from VDD increases to maintain the total current through M7. Any opening and closing of M5 or M6, does not affect the RF input signal in any way. Ex.-2024,¶320.

During his deposition, Dr. Galton attempted to distinguish between absolute or total current from VDD and “signal current” or “signal component” (which he claims moves both upwards and downwards). This distinction is wrong. There is only one physical current in the circuit—the absolute current from VDD. The “signal component” Dr. Galton refers to is not an independent current that flows separately but merely describes how the RF input signal affects the current flow from VDD. The entire current, including any signal variations, flows downward. No portion of the RF input signal current moves upward. Thus, Dr. Galton's reliance on a “signal current” does not change the fact that the current always flows downward. Regardless of his interpretation, the RF input signal is not sampled. Ex.-2024,¶321.

Even if M5 and M6 open and close, the RF input signal remains a continuous signal. The current from the RF input signal always flows through M7 to ground i.e., the RF input signal is never broken into discrete-time samples. Further, the output of the mixer, Vout, is a continuous signal because current is always flowing downward from VDD. Ex.-2024,¶322.

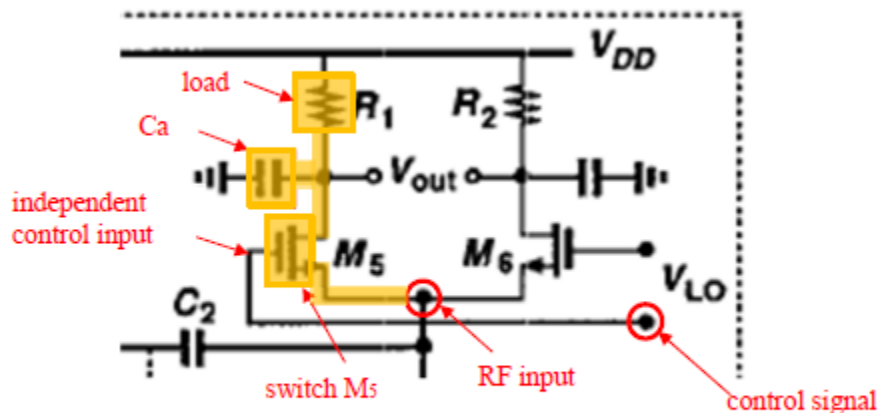
A POSITA understands that a circuit with a continuous input and a continuous output does not perform sampling. Ex.-2024, ¶¶323-324. There is always current flowing from VDD to M7 (either through M5 or M6). The Federal Circuit has already ruled on this issue, finding that a mixer with a continuous input and continuous output does not sample. *See ParkerVision, Inc. v. Qualcomm Inc.*, 621 F. App'x 1009 (Fed. Cir. 2015).

2. Razavi does not disclose, teach, or suggest circuitry for down-converting an input signal “such that energy of the input signal is integrated and transferred to a load to form a down-converted signal.”

Claim 14 recites “down converting said input signal at said [first/second] matched filtering/correlating module.”

Razavi fails to disclose, teach, or suggest circuitry for down-converting an input signal where the energy of the input signal is integrated and transferred to a load to form a down-converted signal. As discussed above in Section VIII.B.1, no current—and therefore no energy—from the RF input signal passes through M5 or M6 to the output of the mixer. Ex.-2024, ¶¶326-327.

Yet, as show below (Galton's annotations), Dr. Galton incorrectly asserts that capacitor C_a integrates/accumulates energy from the RF input. Ex.-1003, ¶166. *See also id.* at ¶178 (discussing the second matched filtering/correlating module). Ex.-2024, ¶328.



Razavi, FIG. 2 (partial, annotated)

Dr. Galton further alleges that “[t]he charge stored on the capacitor Ca discharges through the load R1 when the switch is open.” *Id.* at ¶170; *see also id.* at ¶178 (“In addition to accumulating charge on capacitor Ca, Razavi’s circuit also transfers charge to the load (resistor R2) when the switch is closed.”). Ex.-2024, ¶329.

Dr. Galton’s characterization of the operation of Razavi is wrong. Dr. Galton acknowledges that M5 and M6 are NMOS transistors. And Razavi explicitly discloses that transistors M5 and M6 operate in saturation. A POSITA understands that when NMOS transistors operation in saturation, current can only flow through M5 to M6 in one direction—downward from the drain to the source. This unidirectional current flow directly contradicts Dr. Galton’s assertion that the RF input signal moves in a way that allows it to pass through the transistors and accumulate at capacitor Ca. The capacitors that Dr. Galton identifies cannot possibly

receive any energy from the RF input signal, let alone integrate energy from it. Ex.-2024, ¶330.

Dr. Galton asserts that energy stored in the capacitors from the RF input signal is later discharged or transferred to resistors R_1 and R_2 (Ex.-1003, ¶¶166-168, 170-171, 178-183). The current in Razavi's circuit flows downwards from VDD. No current flows from the RF input signal to the capacitors upward through resistor R_1 or R_2 . Thus, no energy from the RF input signal is transferred from a capacitor to the alleged load. Ex.-2024, ¶¶331-332.

3. Razavi does not disclose, teach, or suggest a “matched filtering/correlating module” under the Florida Court’s construction.

Under the Florida Court’s construction, Razavi fails to disclose, teach, or suggest a “matched filtering/correlating module.” Ex.-2024, ¶334.

For the same reasons discussed above in Section VIII.B.1 and 2, Razavi does not disclose, teach, or suggest: (i) “samples, having non-negligible available energy... are... transferred to a load while the switch is closed and discharged through the load while the switch is open”; or (ii) “transferring available real power from the modulated RF carrier signal to the load and producing a downconverted signal.” No current, charge, or energy is transferred from the RF input signal to resistors R_1 and R_2 (the alleged load) in Razavi. Ex.-2024, ¶335.

Finally, Dr. Galton fails to identify “real power” in Razavi or that such power is transferred from the modulated RF carrier signal to the load. Ex.-1003, ¶¶170-173. As discussed in Sections VIII.B.1 and 2, no current, charge, or energy (and, thus, no power) is transferred from the RF input signal to resistors R_1 and R_2 in Razavi. Thus, there is no transfer of available real power. Ex.-2024, ¶336.

C. Ground 2B: Razavi in view of Uzunoglu

Uzunoglu is only being used for the concept of synchrony and does not resolve the deficiencies of Razavi. Ex.-2024, ¶337.

Thus, Razavi in view of Uzunoglu does not disclose, teach, or suggest all of the elements of claim 14 of the '177 patent for all the same reasons discussed above in Sections VIII.B.1 and 2. Ex.-2024, ¶338.

Dated: March 20, 2025

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that this Patent Owner's Response complies with the type-volume limitation of 37 C.F.R. § 42.24(b) because it contains 13,940 words, as determined by the word-processing program used to prepare the brief, excluding the parts of the brief exempted by 37 C.F.R. § 42.24(a)(1).

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CERTIFICATE OF SERVICE

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