Errata

Title & Document Type: 3325A Synthesizer/Function Generator Operating and Service Manual

Manual Part Number: 03325-90002

Revision Date: May 1984

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 3325A
SYNTHESIZER/FUNCTION GENERATOR

Serial Numbers: All

IMPORTANT NOTICE

This manual applies to all instruments. Earlier versions of the 3325A, however, may differ in design from the instruments this revision documents directly. Design and documenta-

the backdating section (Section VII) where specific information regarding the change is presented.

WARNING

To prevent potential fire or shock hazard, do not expose equipment to rain or moisture.

Manual Part No. 03325-90002

Microfiche Part No. 03325-90052



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HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

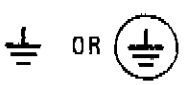
General Definitions of Safety Symbols Used On Equipment or In Manuals.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.



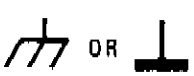
Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.



Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Alternating current (power line).

Direct current (power line).



Alternating or direct current (power line).

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which,if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE:

The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The Operating and Service Manual contains information required to install, operate, test, adjust, and service the Hewlett-Packard Model 3325A Synthesizer/Function Generator. The Operating Manual supplement is a copy of the first three sections of the Operating and Service Manual, plus the Operational Verification procedures from Section IV. The supplement should be kept with the instrument for use by the operator. The part numbers of both the Operating and Service Manual and the Operating Manual supplement are shown on the title pages.

1-3. Also shown on the title page of this manual is a Microfiche part number. This number can be used to order 4 × 6 inch transparencies of the Operating and Service Manual. Each Microfiche contains up to 96 photo-duplicates of the manual pages. The Microfiche package includes the latest Manual Changes supplement as well as pertinent Service Notes.

1-4. Additional copies of the Operating and Service Manual, Operating Information Supplement, or Service Notes can be ordered through your nearest Hewlett-Packard Sales and Service Office. (A list of these offices is provided at the end of this manual.)

1-5. INSTRUMENT DESCRIPTION.

1-6. The Model 3325A Synthesizer/Function Generator produces the following signals at a minimum frequency of 1 μHz and maximum frequency of:

Sine wave	20 MHz
Square wave	10 MHz
Triangle	10 kHz

1-8. The Model 3325A is fully programmable through the rear panel Hewlett-Packard Interface Bus (HP-IB) connector. A device such as a programmable calculator is capable of remotely controlling the 3325A. Interface information is given in Section II of this manual, and programming information is in Section III.

1-9. SPECIFICATIONS.

1-10. Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Any changes in specifications due to manufacturing, design or traceability to the U.S. National Bureau of Standards are included in Table 1-1 of this manual and/or the Manual Changes Supplement.

1-11. SUPPLEMENTAL OPERATING INFORMATION.

1-12. Table 1-2 contains information describing general operating characteristics of the 3325A. This information is supplemental operating information and is not to be considered as specifications.

1-13. REMOTE CONTROL.

1-14. Table 1-3 lists the HP-IB interface capabilities of the Model 3325A in conformity with IEEE Standard 488-1978, "Standard Digital Interface for Programmable Instrumentation". HP-IB response times are given in Table 1-4.

Table 1-1. Specifications.

FUNCTIONS AND FREQUENCIES

Sine Wave:
Signal Output (Front or Rear Panel):
0.000 001 Hz to 20 999 999.999 Hz

Auxiliary Output (Rear Panel):
21 000 000.000 Hz to 60 999 999.999 Hz
Underrange to 19 000 000.001 Hz

Square Wave: 0.000 001 Hz to 10 999 999.999 Hz

Triangle: 0.000 001 Hz to 10 999.999 999 Hz

Positive and Negative Slope Ramp:
0.000 001 Hz to 10 999.999 999 Hz

FREQUENCY RESOLUTION

1 μHz for frequencies below 100 kHz
1 mHz for frequencies 100 kHz and higher

FREQUENCY ACCURACY (Standard Instrument)

$\pm 5 \times 10^{-6}$ of selected value (20° to 30°C)

FREQUENCY STABILITY (Standard Instrument)

$\pm 5 \times 10^{-6}$ per year (20° to 30°C)

SIGNAL CHARACTERISTICS

Sine Wave:
Harmonic Distortion relative to the amplitude of the fundamental frequency at full output on each range

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 50 kHz	−65 dB
50 kHz to 200 kHz	−60 dB
200 kHz to 2 MHz	−40 dB
2 MHz to 15 MHz	−30 dB
15 MHz to 20 MHz	−25 dB

Spurious: All non-harmonically related output signals will be more than 70dB below the carrier (-60dB with DC offset), or less than -90dBm, whichever is greater.

Phase Noise: ≥ -60dB (Option 001 Only) for a 30kHz band centered on a 20MHz carrier (excluding ± 1Hz about the carrier).

Square Wave:
Rise/Fall Time: ≤ 20 nanoseconds, 10% to 90% at full output

Symmetry: ≤ .02% of period + 3 nanoseconds

Overshoot: ≤ 5% of peak to peak amplitude at full output

Triangle:

Linearity, 10% to 90%, best fit straight line:
± 0.05% of full p-p output for each range

Ramps (Positive or Negative Slope):

Linearity, 10% to 90%, best fit straight line: ± 0.05% of full p-p output for each range

Retrace Time: ≤ 3 microseconds, 90% to 10%

Ramp Period Variation: < ± 1% of period, maximum

AMPLITUDE

Amplitude Accuracy with no Attenuation (Attenuator range 1) into 50 ohm Load. (No D.C. offset)

Function and frequency range	Tolerance relative to programmed amplitude
Sine Wave .001 Hz to 100 kHz	± 0.1 dB
Square Wave .001 Hz to 100 kHz	± 1.0%
Triangle .001 Hz to 2 kHz 2 kHz to 10 kHz	± 1.5% ± 5%
Ramps .001 Hz to 500 Hz 500 Hz to 10 kHz	± 1.5% ± 10%

Flatness with no attenuation (Attenuator Range 1) into a 50 Ohm load	Tolerance relative to programmed amplitude at 1 kHz
Sine Wave 100 kHz to 20 MHz	± 0.3 dB
Square Wave 100 kHz to 10 MHz	± 10%

Amplitude accuracy with D.C. offset and no attenuation (Range 1) into a 50 ohm load.	Tolerance relative to programmed amplitude.
Sine Wave .001 Hz to 100 kHz	± 0.3 dB
Square .001 Hz to 100 kHz	± 3%
Triangle .001 Hz to 2 kHz 2 kHz to 10 kHz	± 4% ± 6%
Ramps .001 Hz to 500 Hz 500 Hz to 10 kHz	± 4% ± 11%

Attenuator Accuracy (these errors are additive with the amplitude accuracy errors)	Tolerance relative to programmed amplitude.
.001 Hz to 20 kHz Attenuator Range 1	No Error
.001 Hz to 100 kHz Attenuator ranges 2 through 8	± 0.1 dB
100 kHz to 10 MHz Attenuator ranges 2 through 8	± 0.2 dB
10 MHz to 20 MHz Attenuator ranges 2 through 4 Attenuator ranges 5 through 8	± 0.2 dB ± 0.5 dB

Table 1-1. Specifications (Cont'd).

Accuracy of DC Offset (into 50 ohms):

DC Only (No AC Function): ± 0.4% of full peak output for each range*

*Except lowest attenuator range where accuracy is ± 20 μV.

DC + AC, ≤1 MHz: ±1.2%, Ramps ±2.4%

DC + AC, >1 MHz: ±3%

AMPLITUDE MODULATION (of Sine Function only)

Modulation Envelope Distortion: −30 dB to 80% modulation at 1 kHz, 0 V dc Offset

PHASE OFFSET

Range: ±719.9° with respect to arbitrary starting phase, or assigned zero phase

Resolution: 0.1°
Stability: ± 1° phase/°C
Increment Accuracy: ±0.2°

PHASE MODULATION

Linearity (Sine Function): ±0.5%, best fit straight line

SYNC OUTPUT

Output Levels into 50 ohms:
Square wave with $V_{high} \geq +1.2V$, $V_{low} \leq +0.2V$

X DRIVE OUTPUT

Linearity, 10% to 90%, best fit straight line: ±0.1% of final value. Specified for all linear sweep widths which are integral multiples of the minimum sweep width for each function and sweep time.

OPTION 001

HIGH STABILITY FREQUENCY REFERENCE

Ambient Stability: $\pm 5 \times 10^{-8}$ (0° to 55°C referenced to +30°C)

Aging Rate: $\pm 5 \times 10^{-8}$ per week (after 72 hours continuous operation)
$\pm 1 \times 10^{-7}$ per month (after 15 days continuous operation)

OPTION 002

HIGH VOLTAGE OUTPUT

Frequency Range:
Sine and Square Wave: 1 μHz to 1 MHz
Triangle and Ramps: 1 μHz to 10 kHz

Amplitude:

Range: 4mVp-p to 40Vp-p (≥ 500Ω, < 500pF load) maximum output current, ± 40mA

Accuracy (at 2 kHz): ±2% of full output for each range

Flatness: ±10% of programmed amplitude

DC Offset:
Range: 4 times the range of the standard instrument

Accuracy: ±(1% +25 mV) of full output for each range

Signal Characteristics:
Sine Wave Harmonic Distortion (relative to the fundamental frequency at full output into ≥500 ohms, <500 pF).

10 Hz to 50 kHz	−65 dB
50 kHz to 200 kHz	−60 dB
200 kHz to 1 MHz	−40 dB

Square Wave:

Rise/Fall Time: ≤ 125 nanoseconds, 10% to 90% at full output with ≥ 500 ohm, < 500pF load

Overshoot: <10% of peak amplitude with ≥500 ohm, <500 pF load

Table 1-2 Supplemental Information

MAIN SIGNAL OUTPUT

50 Ω Impedance

BNC Connector, switchable to front or rear panel (not switchable with Option 002)

May be floated a maximum of ±42 V peak (ac + dc) from chassis (earth) ground

Amplitude Ranges:
All AC Functions (with no dc offset):

Range No.	Attenuation Factor	Amplitude (Peak-to-Peak)
1	1	10.00 V to 3.000 V
2	3	2.999 V to 1.000 V
3	10	999.9 mV to 300.0 mV
4	30	299.9 mV to 100.0 mV
5	100	99.99 mV to 30.00 mV
6	300	29.99 mV to 10.00 mV
7	1000	9.999 mV to 3.000 mV
8	3000	2.999 mV to 1.000 mV

DC Offset Only:

Range No.	Attenuation Factor	Amplitude (Peak-to-Peak)
1	1	5.000 V to 1.500 V
2	3	1.499 V to 500.0 mV
3	10	499.9 mV to 150.0 mV
4	30	149.9 mV to 50.00 mV
5	100	49.99 mV to 15.00 mV
6	300	14.99 mV to 5.000 mV
7	1000	4.999 mV to 1.500 mV
8	3000	1.499 mV to 1.000 mV

Table 1-2. Supplemental Information (Cont'd).

AC Function with DC Offset:

Range No.	Attenuation Factor	AC Function Amplitude (p-p)	Maximum DC (+ or −)	Min. DC (+ or −)
1	1	9.998 V to 1.000 V	1.000 mV to 4.500 V	1.000 mV
2	3	999.9 mV to 333.4 mV	1.166 V to 1.499 V	0.100 mV
3	10	333.3 mV to 100.0 mV	333.3 mV to 450.0 mV	0.100 mV
4	30	99.99 mV to 33.34 mV	116.6 mV to 149.9 mV	0.010 mV
5	100	33.33 mV to 10.00 mV	33.33 mV to 45.00 mV	0.010 mV
6	300	9.999 mV to 3.334 mV	11.66 mV to 14.99 mV	0.001 mV
7	1000	3.333 mV to 1.000 mV	3.333 mV to 4.500 mV	0.001 mV

High Voltage Output Option 002:
Amplitude and Ranges: 4 times the standard instrument amplitudes

Output Impedance: < 2 Ω at DC to < 10 Ω at 1 MHz

Square Wave Settling Time: < 1 μs to settle to within .05% of final value for frequencies of 10 Hz to 500 kHz, tested at full output with no load

FREQUENCY SWEEP

Sweep Time:
Linear Sweep: 0.01 second to 99.99 seconds (single or continuous)

Log Sweep:
Single Sweep: 2 seconds to 99.99 seconds
Continuous Sweep: 0.1 second to 99.99 seconds

Minimum Sweep Width: 1 Hz to maximum frequency of the function selected

Minimum Sweep Width (Linear):

Minimum Sweep Width

Function	Sweep Time 0.01 second	Sweep Time 99.99 seconds
Sine	0.1 mHz	999.9 mHz
Square	0.05 mHz	499.5 mHz
Triangle	0.005 mHz	49.95 mHz
Ramps	0.01 mHz	99.99 mHz

Minimum Sweep Width (Log): 1 decade

Phase Continuity: Sweep is phase continuous over the full frequency range

WARMUP TIME

Standard Instrument: 20 minutes to within specified accuracy

Option 001 High Stability Frequency Reference:
Reference will be within $\pm 1 \times 10^{-7}$ of final value 15 minutes after turn-on at 25°C for an off time of less than 24 hours

AUXILIARY INPUTS (May be floated a maximum of ±42 V peak [ac + dc] from chassis [earth] ground)

Reference: For phase-locking the 3325A to an external frequency reference of 10 MHz or a subharmonic of 10 MHz down to 1 MHz. Level must be 0 dBm to +20 dBm into 50 ohms. Rear panel BNC connector.

Amplitude Modulation Input (Sine Function Only):

Modulation depth at full output for each range: 0 to 100%

Modulation frequency range: DC to 500 kHz (0 to 21 MHz carrier frequency)

Sensitivity: 5 V peak for 100% modulation

Input Impedance: 10 kΩ

Connector: Rear panel BNC

Phase Modulation:
Modulation Frequency Range: DC to 5 kHz

Modulation Depth

Function	Depth (+ or −)
Sine	850°
Square	425°
Triangle	42.5°
Ramps	85°

Input Impedance: 20 kΩ

Connector: Rear panel BNC

AUXILIARY OUTPUTS (May be floated a maximum of ±42 V peak [ac + dc] from chassis [earth] ground)

Auxiliary Frequency Output (ac coupled output):

Frequency Range: 21 MHz to 60.999 999 999 MHz, with underrange coverage to 19.000 000 001 MHz

Amplitude: 0 dBm

Output Impedance: 50 ohms

Connector: Rear panel BNC

1 MHz Reference Output (for phase-locking other instruments to 3325A):

Amplitude: 0 dBm

Output Impedance: 50 ohms

Connector: Rear panel BNC

Marker Output (Linear sweep only):

Levels: High to Low TTL compatible voltage transition at selected marker frequency, sweep up only.

Connector: Rear panel BNC

Table 1-2. Supplemental Information (Cont'd).

X Drive Output (Sweep up only):
Amplitude: 0 to + 10 V linear ramp proportional to sweep frequency

Connector: Rear panel BNC

Z Blank Output:
Levels (TTL compatible voltage levels):
Linear Sweep:
Single: Low at start of sweep, High at stop. Remains High until start of next sweep.

Continuous: Low during sweep up, High during sweep down.

Log Sweep:
Single: Low at start of sweep, High at stop. Remains High until start of next sweep.

Continuous: Low during sweep. Goes High momentarily at stop frequency.

10 MHz Oven Reference Output, Option 001, for phase locking the 3325A to the optional high stability frequency reference:

Amplitude: 0 dBm, 50 ohms

Connector: Rear panel BNC. Must be connected to the rear panel EXT REF IN connector.

REMOTE CONTROL

Hewlett-Packard Interface Bus (HP-IB) Control: (HP-IB is Hewlett-Packard Company's implementation of IEEE Standard 488-1978). Time shown is in addition to programming time.

Frequency Switching and Settling Time:*

< 10 ms to within 1 Hz of final value for 100 kHz span

< 25 ms to within 1 Hz of final value for 1 MHz span

< 70 ms to within 1 Hz of final value for 20 MHz span

Phase Switching and Settling Time:*
< 15 ms to within 90° of phase lock for 20 MHz frequency change

Amplitude Switching Time:*
< 30 ms to within amplitude specifications

*Times shown are in addition to programming time

GENERAL

Operating Environment:

Temperature: 0° to 55°C
Relative Humidity: <95%, 0° to 40°C
Altitude: ≤ 15,000 ft.

Storage Temperature: −50° to +75°C
Storage Altitude: ≤50,000 ft.

Power Requirements:

100/120/220/240V + 5%, − 10%, 48 to 66 Hz
60 VA 100 VA with all options, 10 VA standby

Dimensions in millimeters and (inches):

132.6 (5¼) high × 425.5 (16¾) wide × 497.8 (19-5/8) deep

Weight in kilograms and (lbs):

Net weight: 9(20)
Shipping Weight: 14.5 (32)

The following accessory options are also available for the Model 3325A:

Option 907	Front Handle Assembly
Option 908	Rack Mount Flange Kit
Option 909	Rack Mount Flange Kit/Front Handle Assembly
Option 910	Additional Operating and Service Manual

1-17. ACCESSORIES SUPPLIED.

1-18. A special connector is supplied with the High Stability Frequency Reference Option 001 for connecting the rear panel Reference Output to the Reference Input. This connector is Part No. 1250-1499.

1-19. ACCESSORIES AVAILABLE.

1-20. The following accessories are available for use with the Model 3325A:

Number	Description
11048C	50 ohm Feedthru Termination
11356A	Ground Isolator
03325-80001	Oven Board Assy. (Converts 3325A to Option 001)
03325-80002	High Voltage Option (Converts 3325A to Option 002)
5061-0077	Rack Mount Flange Kit (Option 908)
5061-0083	Rack Mount Flange/Front Handle Kit (Option 909)
5061-0089	Front Handle Kit (Option 907)

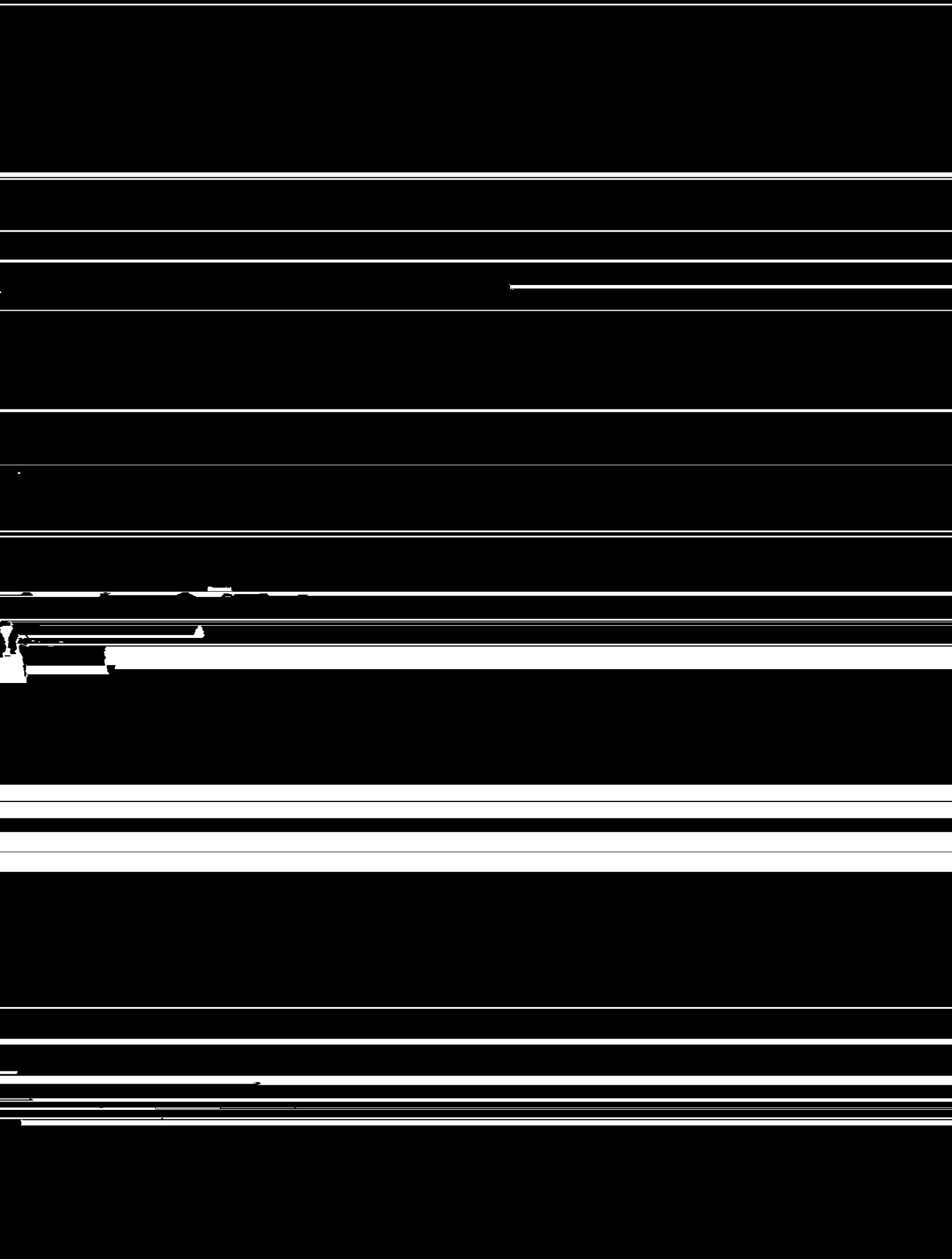
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Table 1-4. HP-IB Response Times.

Function	Mnemonic	Input Data Transfer Time	Device Time	Output Data Transfer Time
Function (Waveform) 1 Digit	FU	450-500 μs 225-250 μs	1600 ms 2.8 ms	450-500 μs 225-250 μs
Frequency ≤11 Digits + Decimal Delimiters	FR HZ, KH, or MH	450-500 μs 225-250 μs each 450-500 μs	7.0 ms 2.8 ms each 12.5 ms	450-500 μs 225-250 μs each 450-500 μs
Amplitude ≤4 Digits + Decimal Delimiters	AM VO or MV VR or MR DB	450-500 μs 225-250 μs each 450-500 μs 450-500 μs 450-500 μs	6.8 ms 2.8 ms each 90 ms 130 ms 250 ms	450-500 μs 225-250 μs each 450-500 μs 450-500 μs 450-500 μs
DC Offset ≤4 Digits + Decimal Delimiters	OF VO or MV	450-500 μs 225-250 μs each 450-500 μs	6.8 ms 2.8 ms each 82 ms	450-500 μs 225-250 μs each 450-500 μs
Phase ≤4 Digits + Decimal Delimiter	PH DE	450-500 μs 225-250 μs each 450-500 μs	5 ms 2.8 ms each 28 ms	450-500 μs 225-250 μs each 450-500 μs
Sweep Start Frequency ≤11 Digits + Decimal Delimiters	ST HZ, KH, or MH	450-500 μs 225-250 μs each 450-500 μs	7.0 ms 2.8 ms each 10.3 ms	450-500 μs 225-250 μs each 450-500 μs
Sweep Stop Frequency ≤11 Digits + Decimal Delimiters	SP HZ, KH or MH	450-500 μs 225-250 μs each 450-500 μs	7.0 ms 2.8 ms each 10.3 ms	450-500 μs 225-250 μs each 450-500 μs
Sweep Marker Frequency ≤11 Digits + Decimal Delimiters	MF HZ, KH or MH	450-500 μs 225-250 μs each 450-500 μs	7.0 ms 2.8 ms each 10.3 ms	450-500 μs 225-250 μs each 450-500 μs
Sweep Time ≤4 Digits + Decimal Delimiter	T1 SE	450-500 μs 225-250 μs each 450-500 μs	5.5 ms 2.8 ms each 7.0 ms	450-500 μs 225-250 μs each 450-500 μs
Store	SR	450-500 μs	11 ms	
Recall	RE	450-500 μs	1700 ms	
Assign Zero Phase	AP	450-500 μs	5.2 ms	
Amptd Cal	AC	450-500 μs	1500 ms	
Start Single Sweep	SS	450-500 μs	300 ms	
Start Continuous Sweep	SC	450-500 μs	300 ms	
Interrogate (Add Parameter Mnemonic Time)	I	225-250 μs	3 ms	
Mask Service Request	MS	450-500 μs	4.5 ms	
High Voltage Output	HV	450-500 μs	48 ms	
Rear/Front Output	RF	450-500 μs	44.5 ms	
Self Test	TE	450-500 μs	10,000 ms	
Sweep Mode	SM	450-500 μs	4.5 ms	
Data Transfer Mode	MD	450-500 μs	4.5 ms	
Interrogate Function	IFU	675-750 μs	1603 ms	
Interrogate Error	IER	675-750 μs	11.5 ms	
Universal Commands		~225 μs per byte		
Amplitude Modulation	MA	450-500 μs	7.0 ms	
Phase Modulation	MP	450-500 μs	7.0 ms	

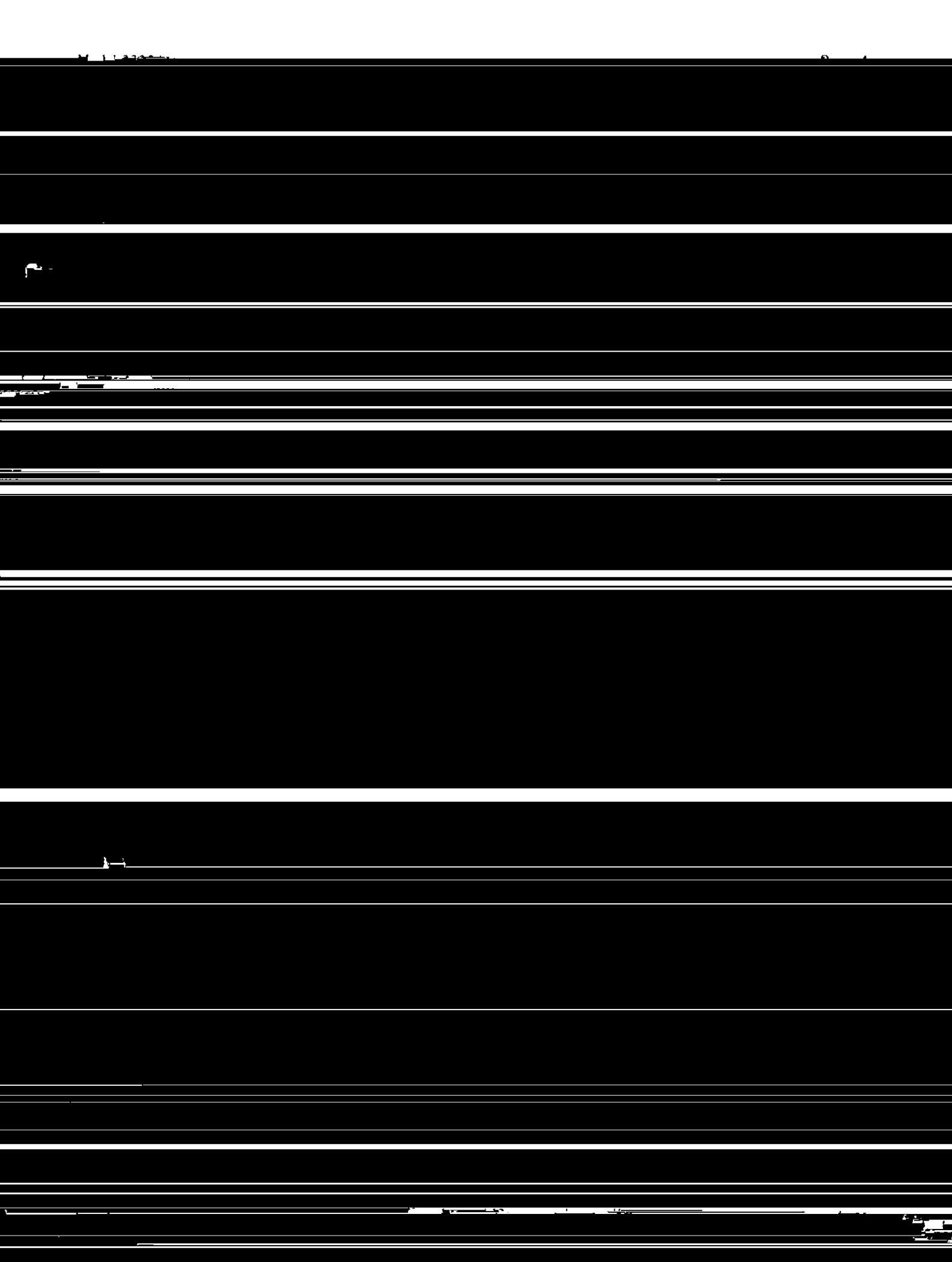
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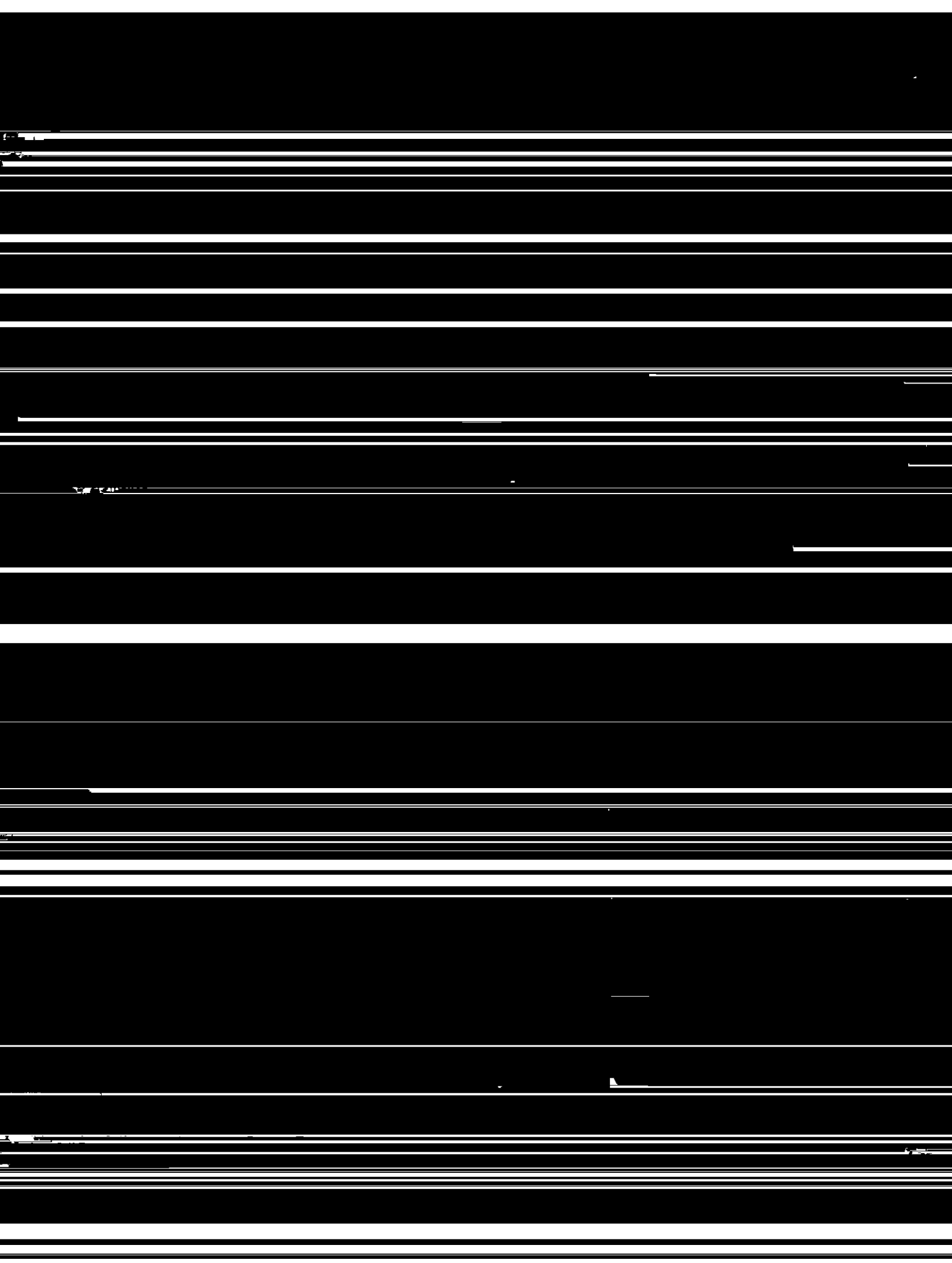
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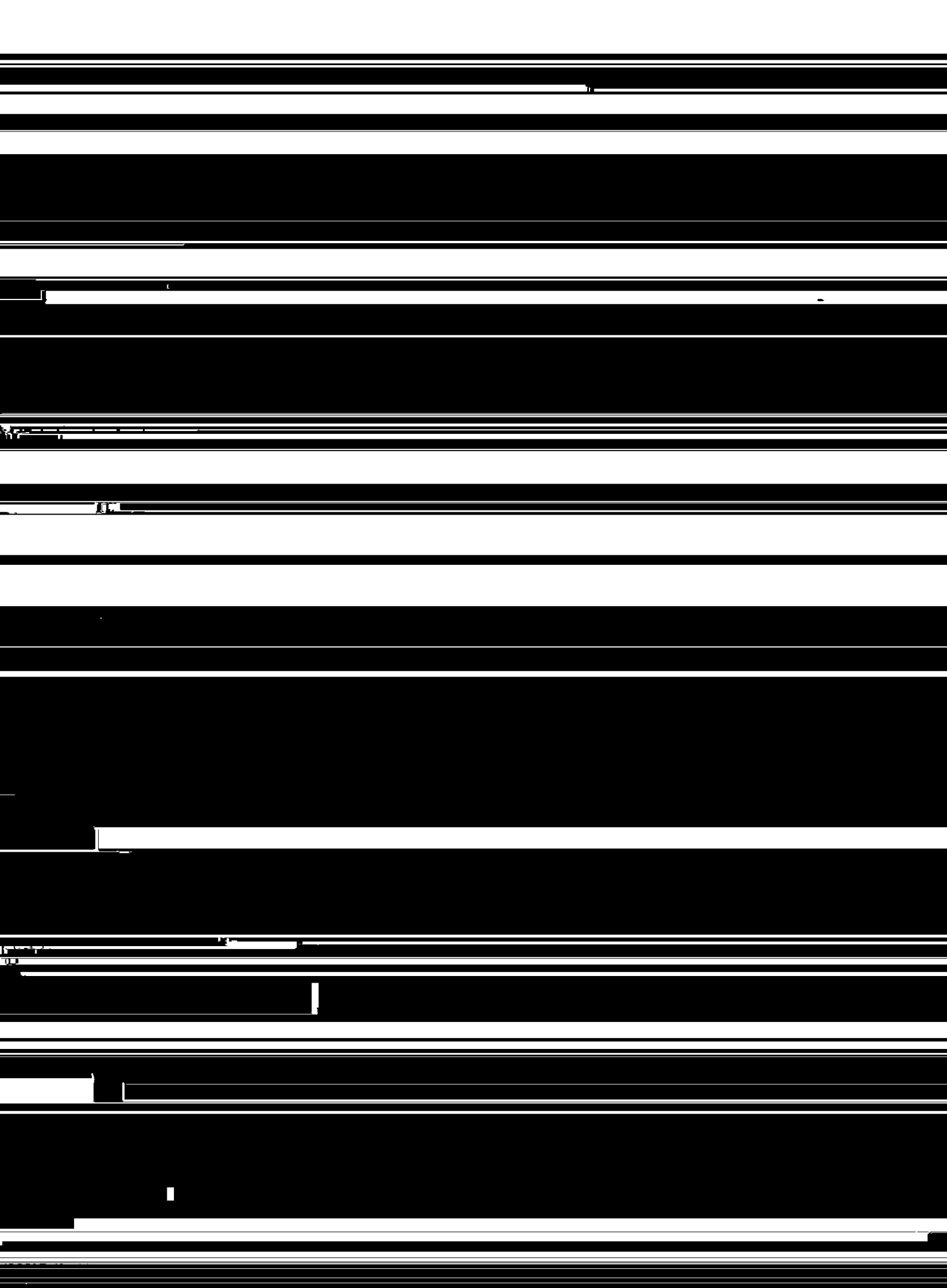
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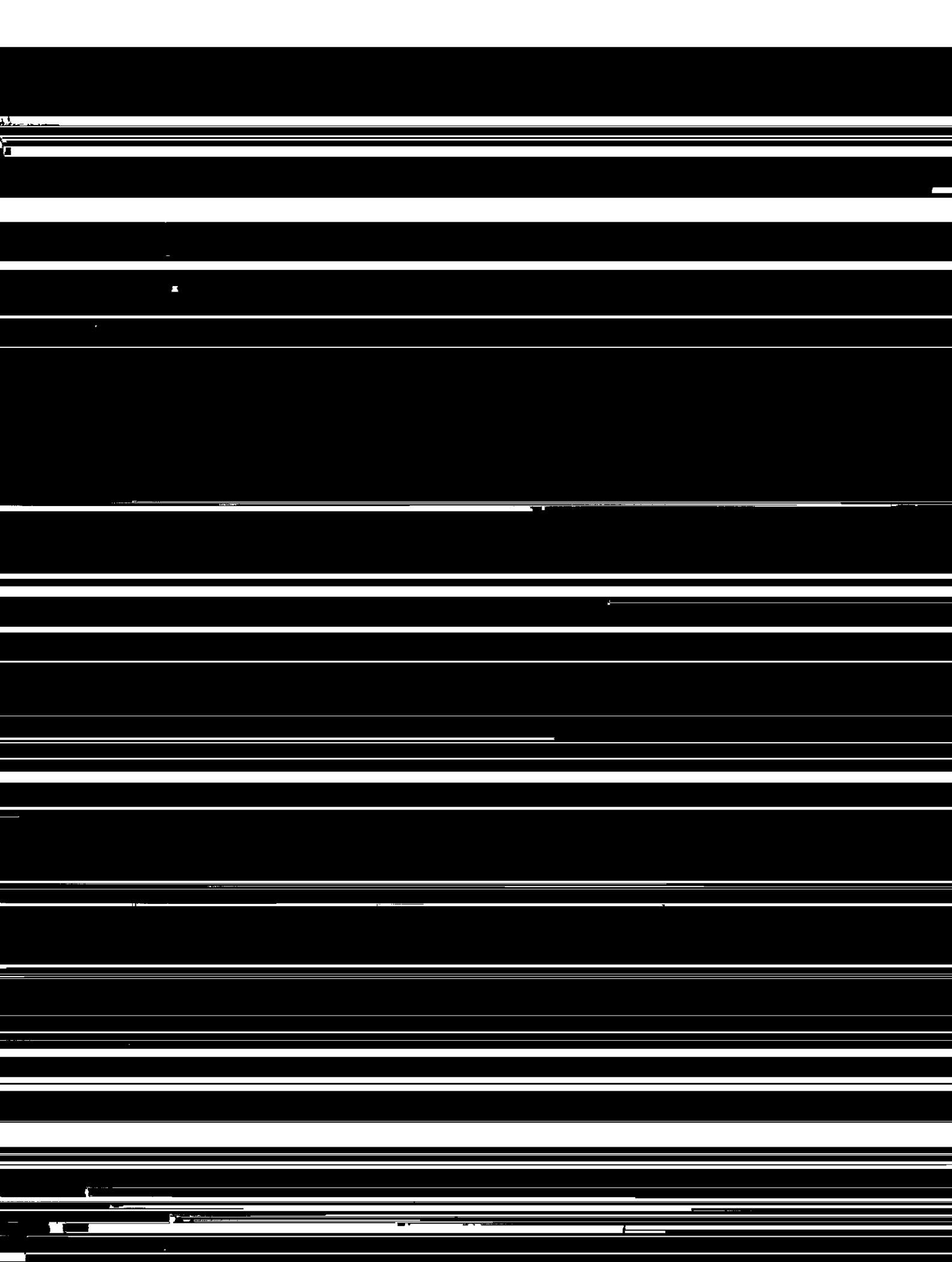
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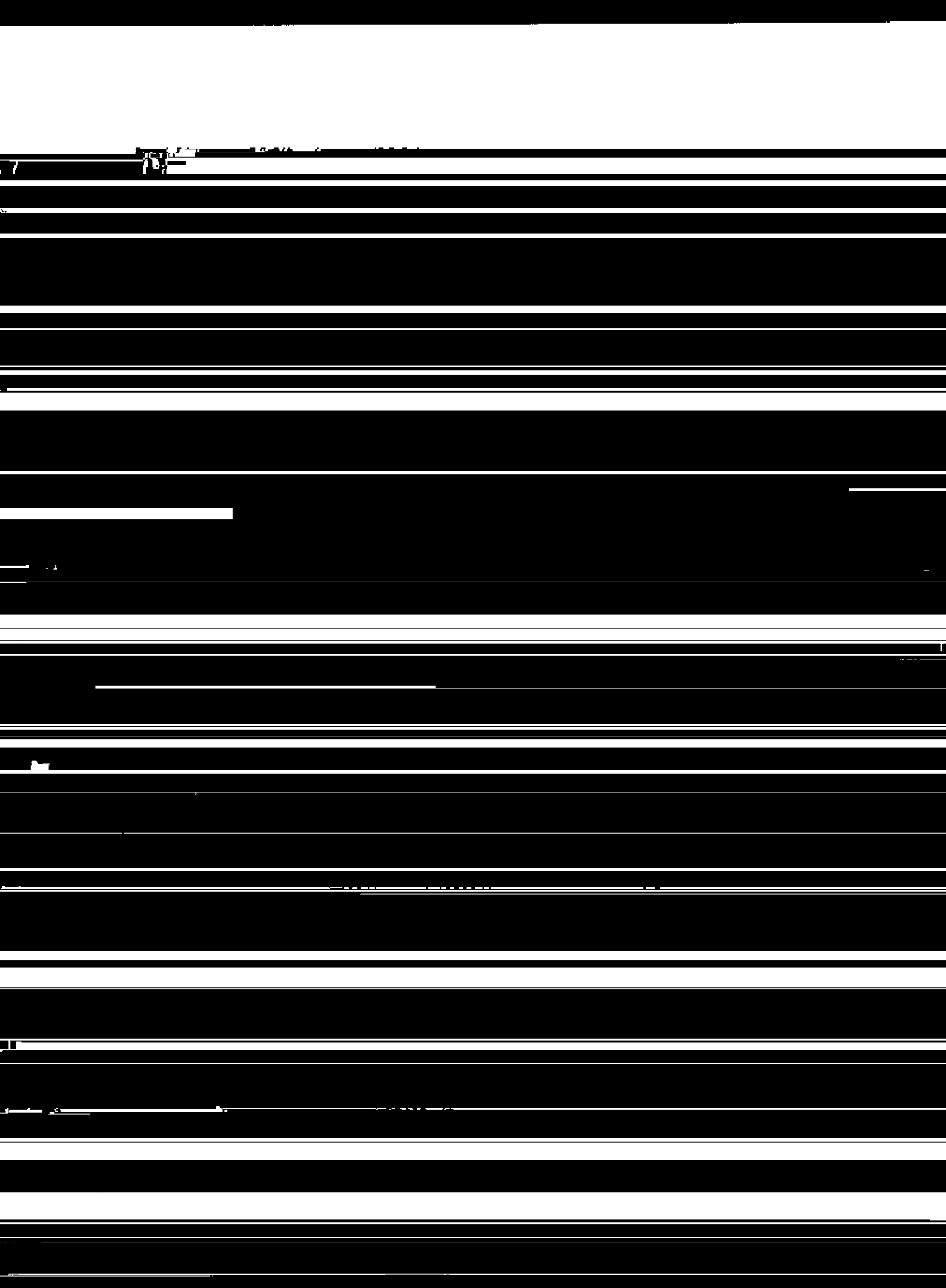


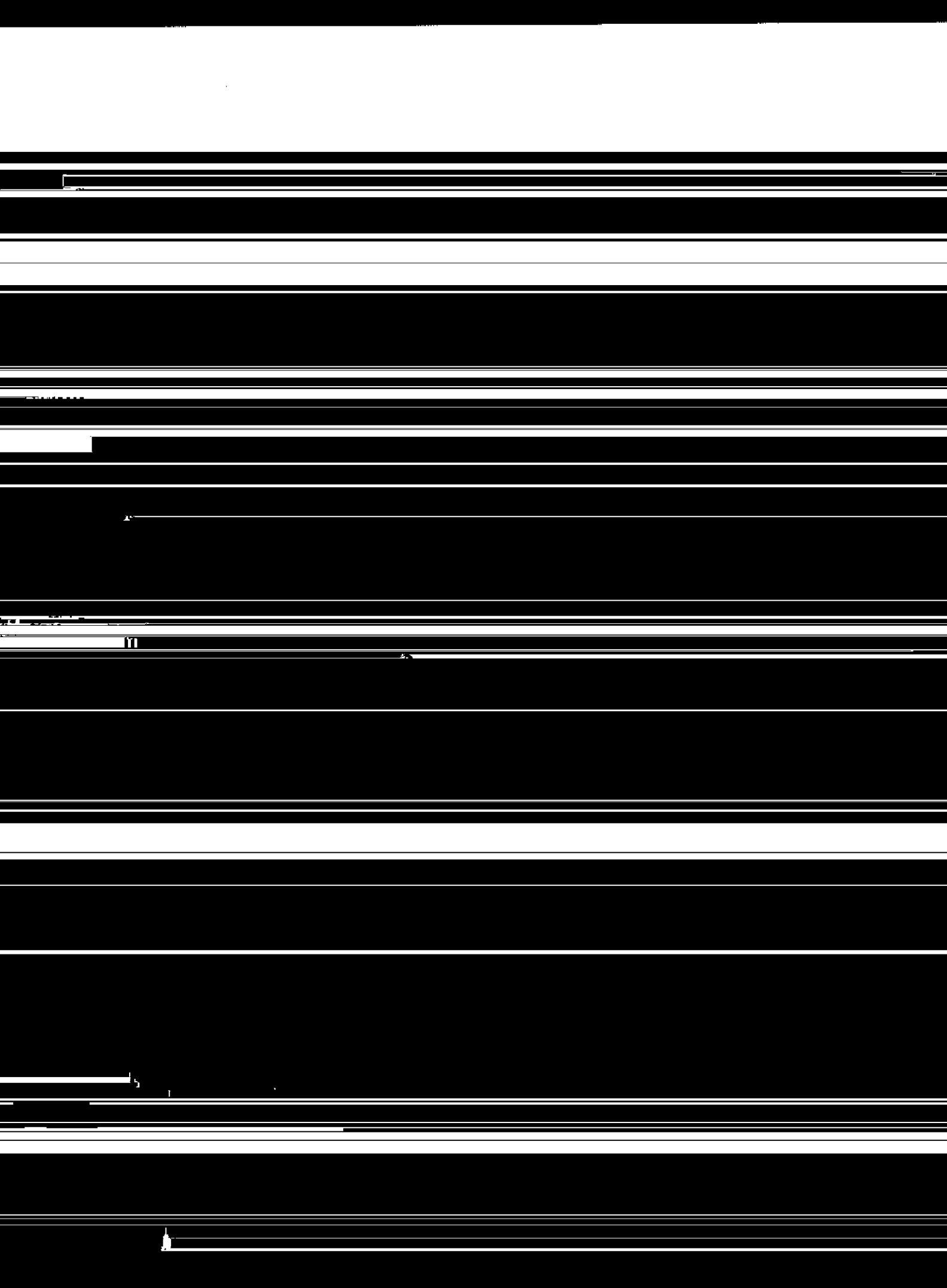


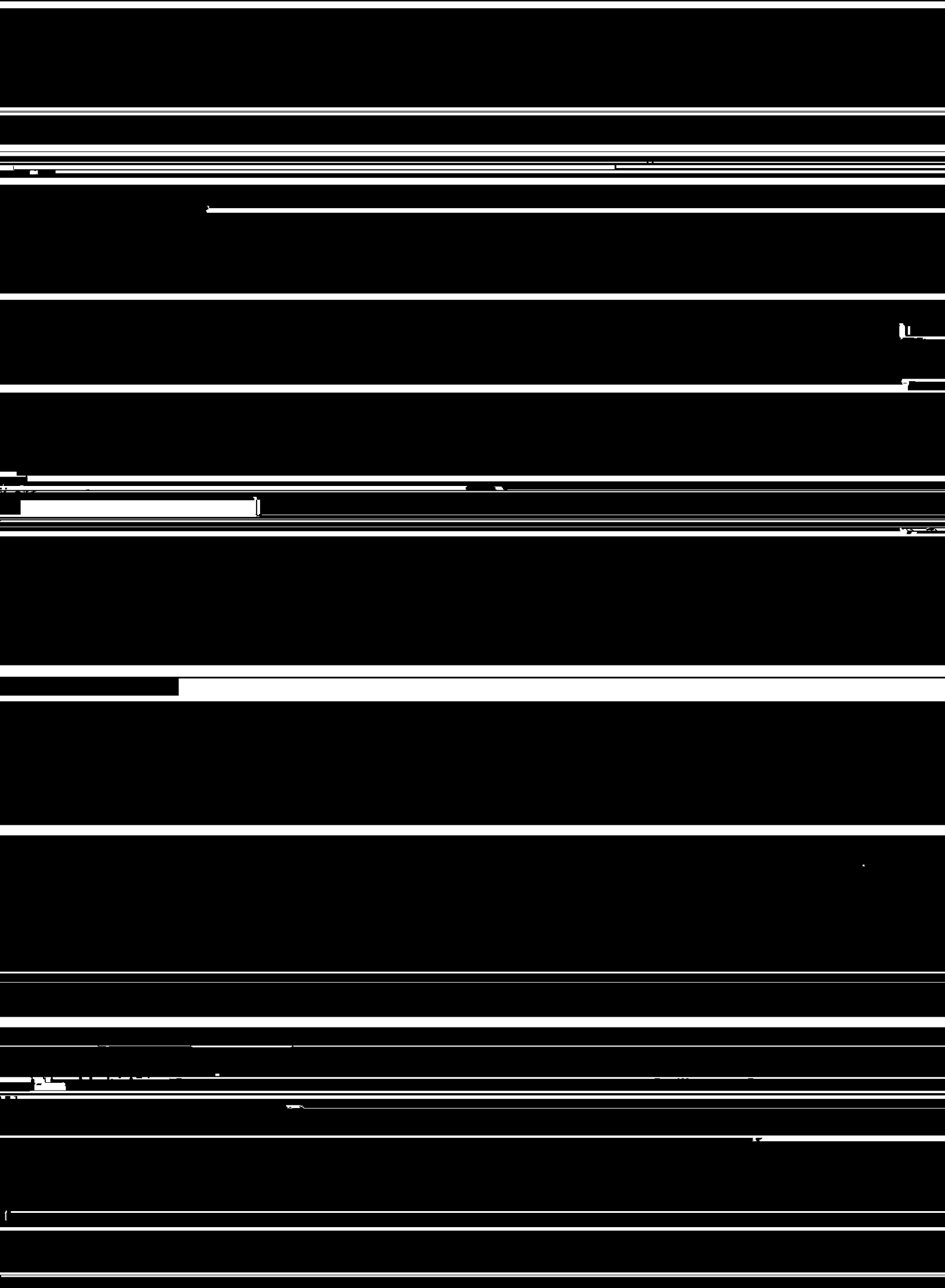


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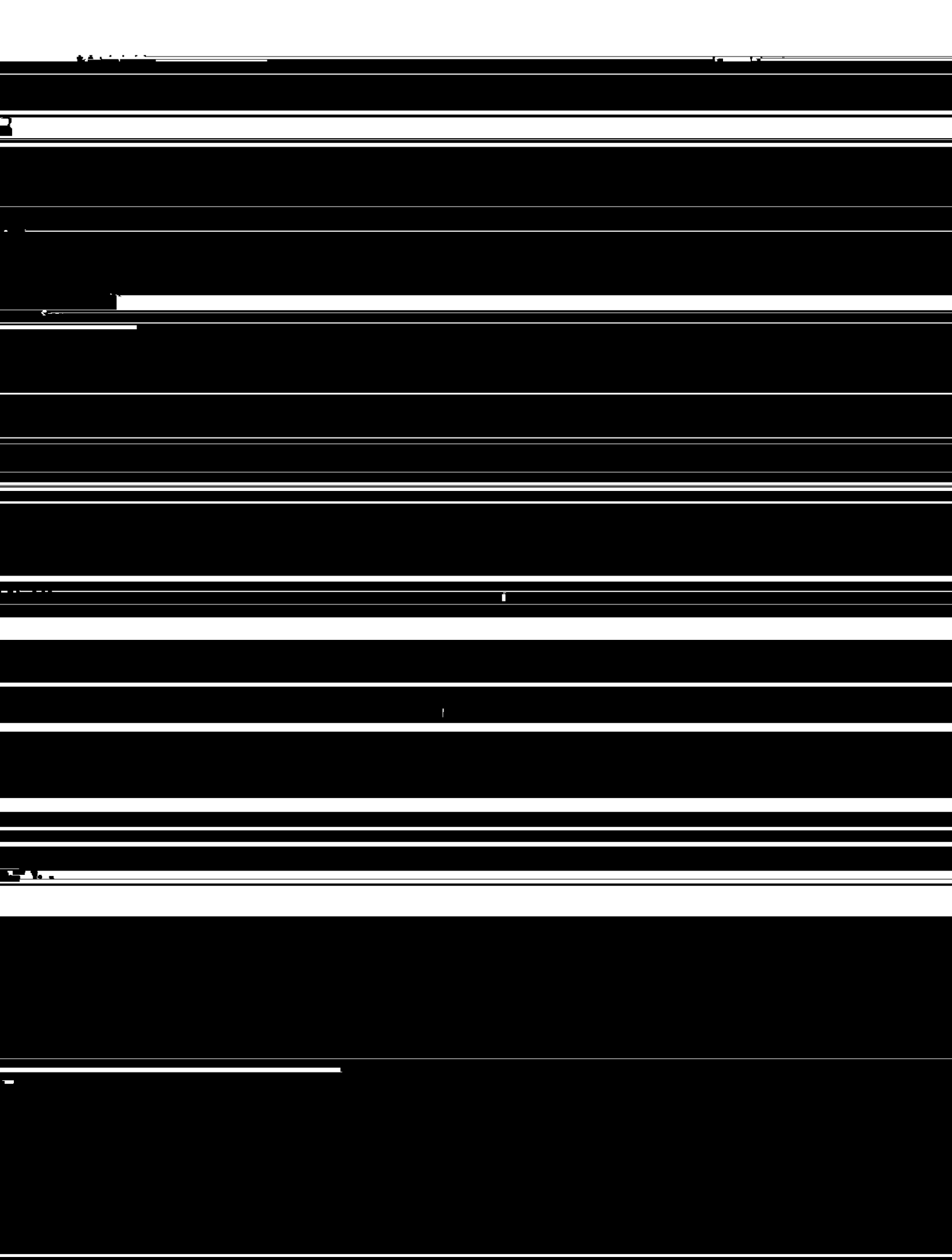




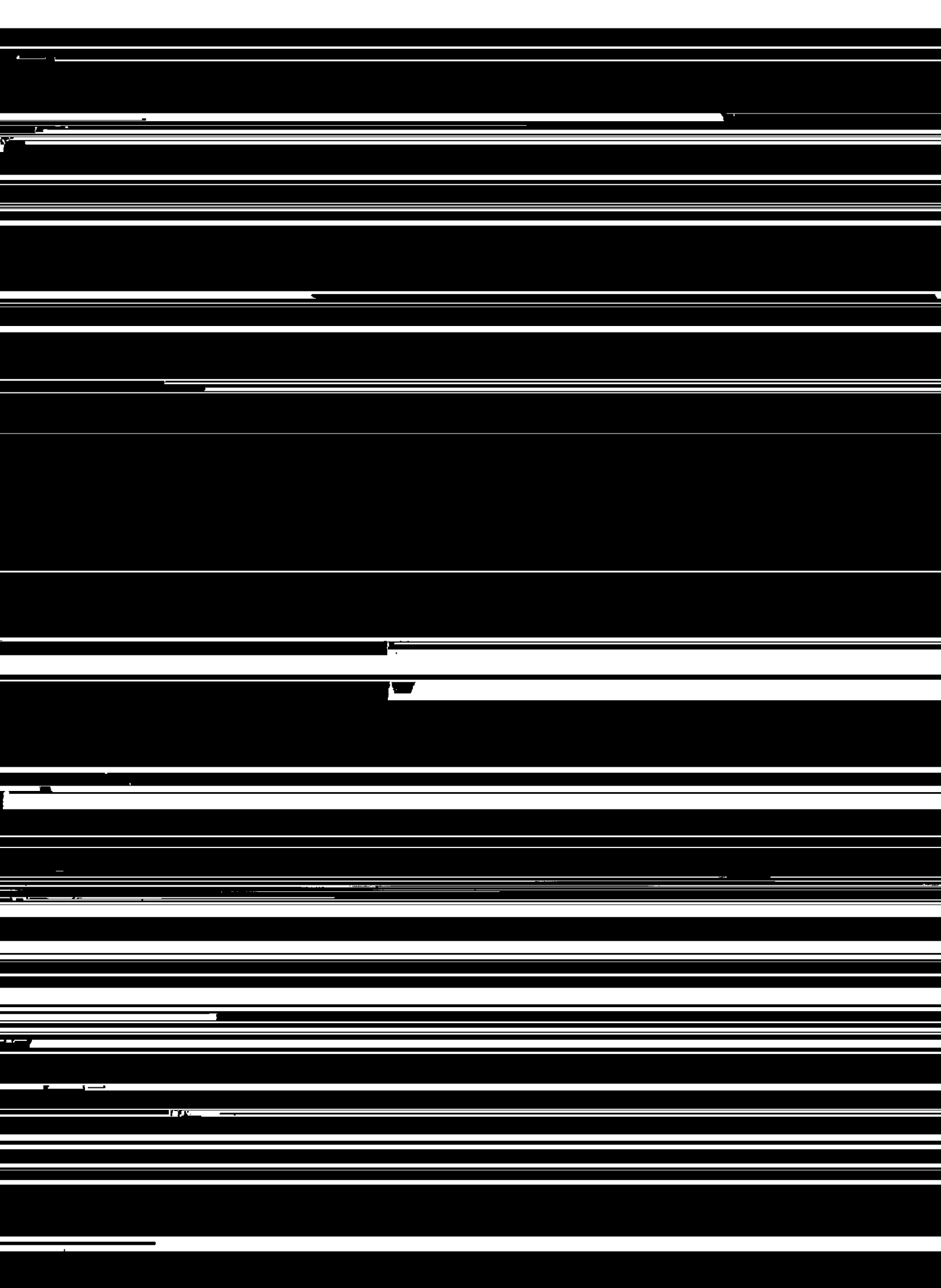


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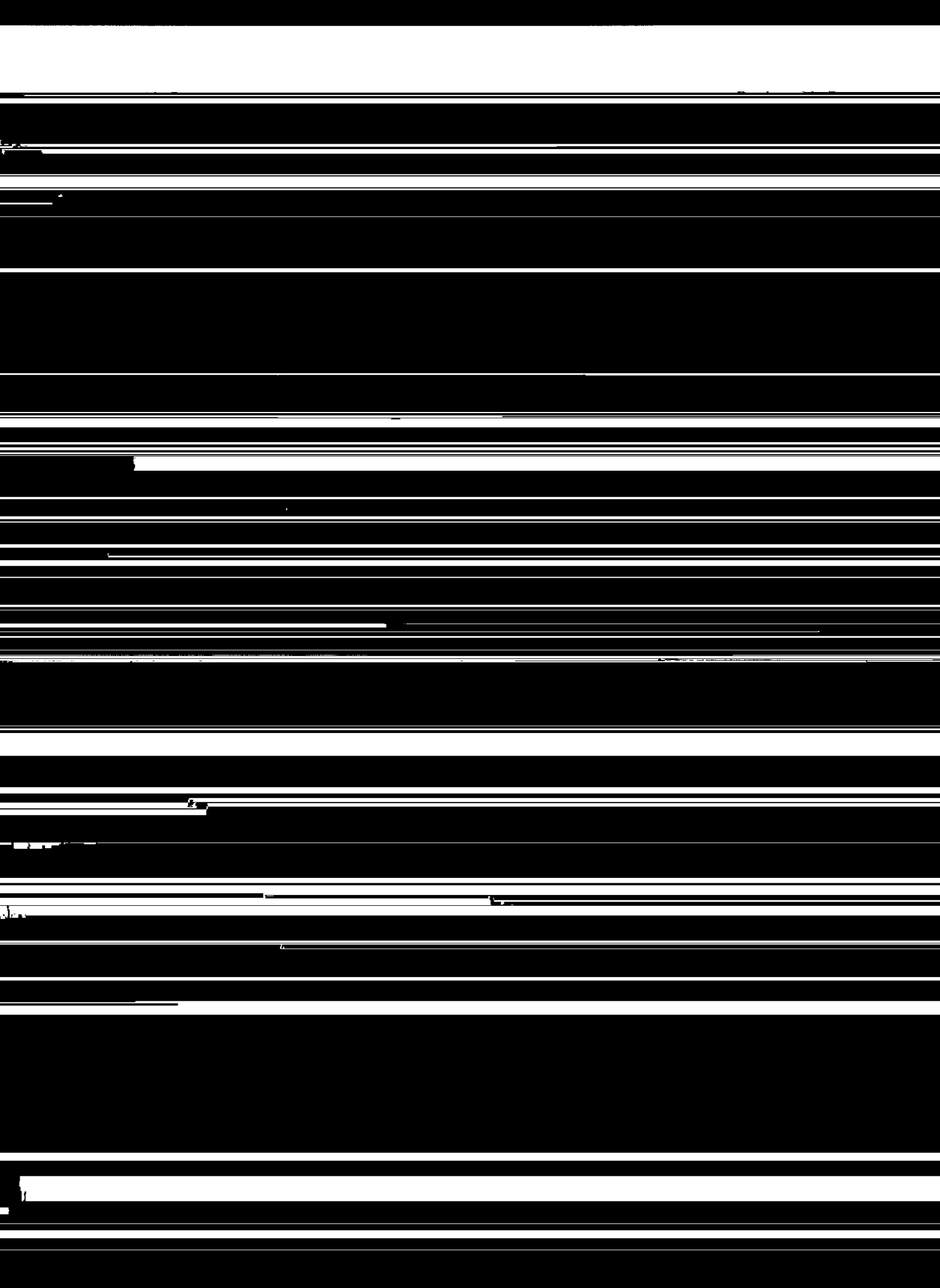
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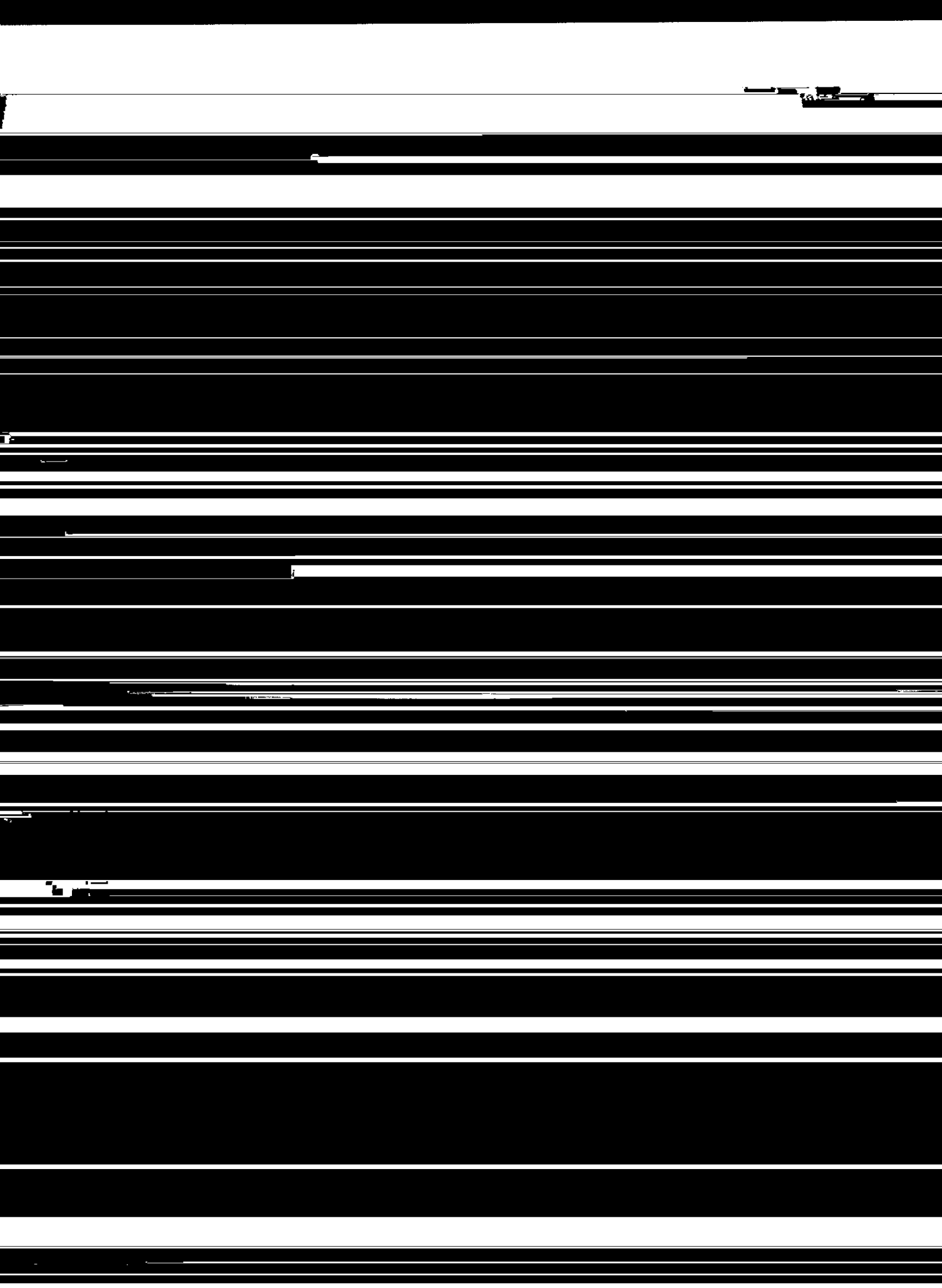
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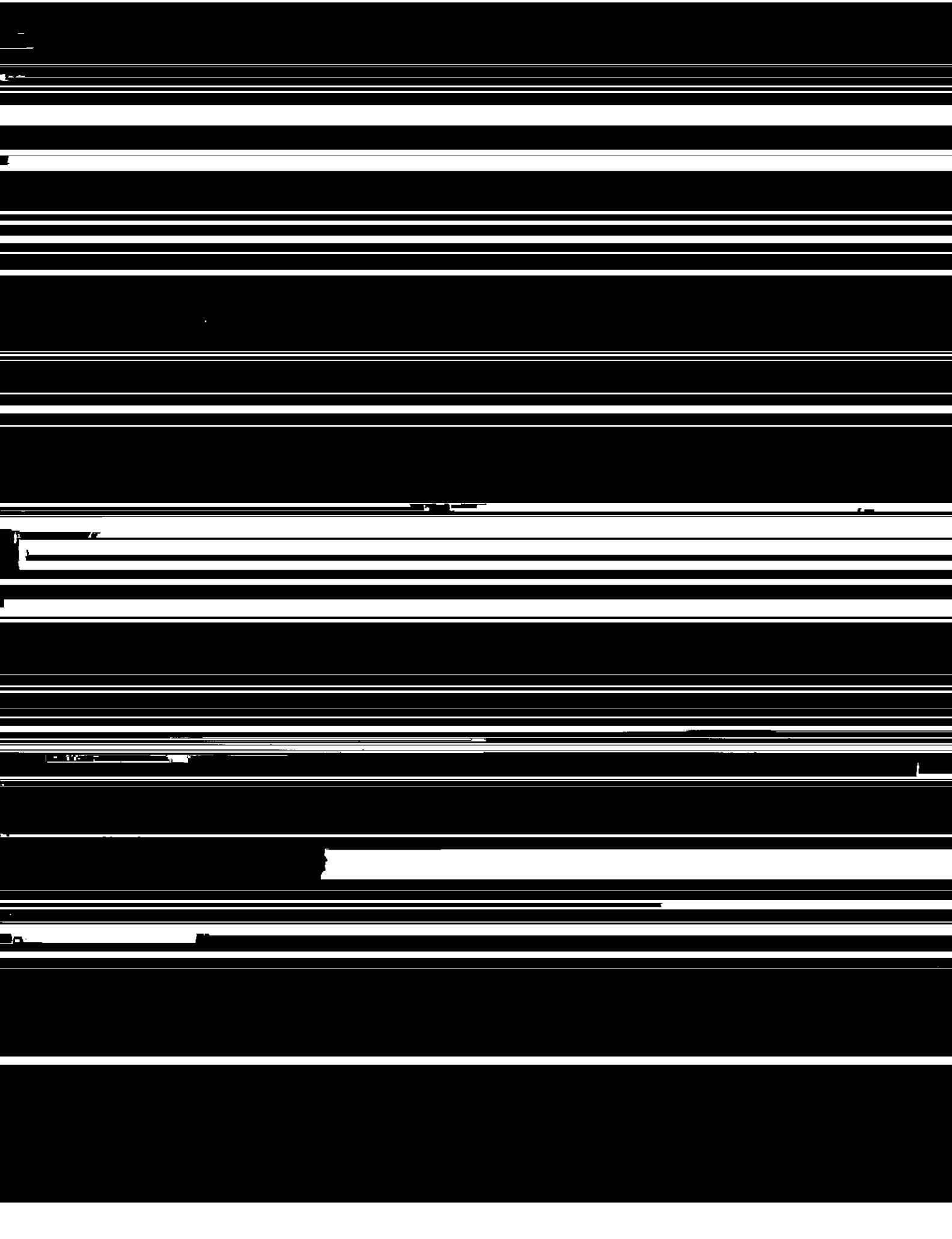
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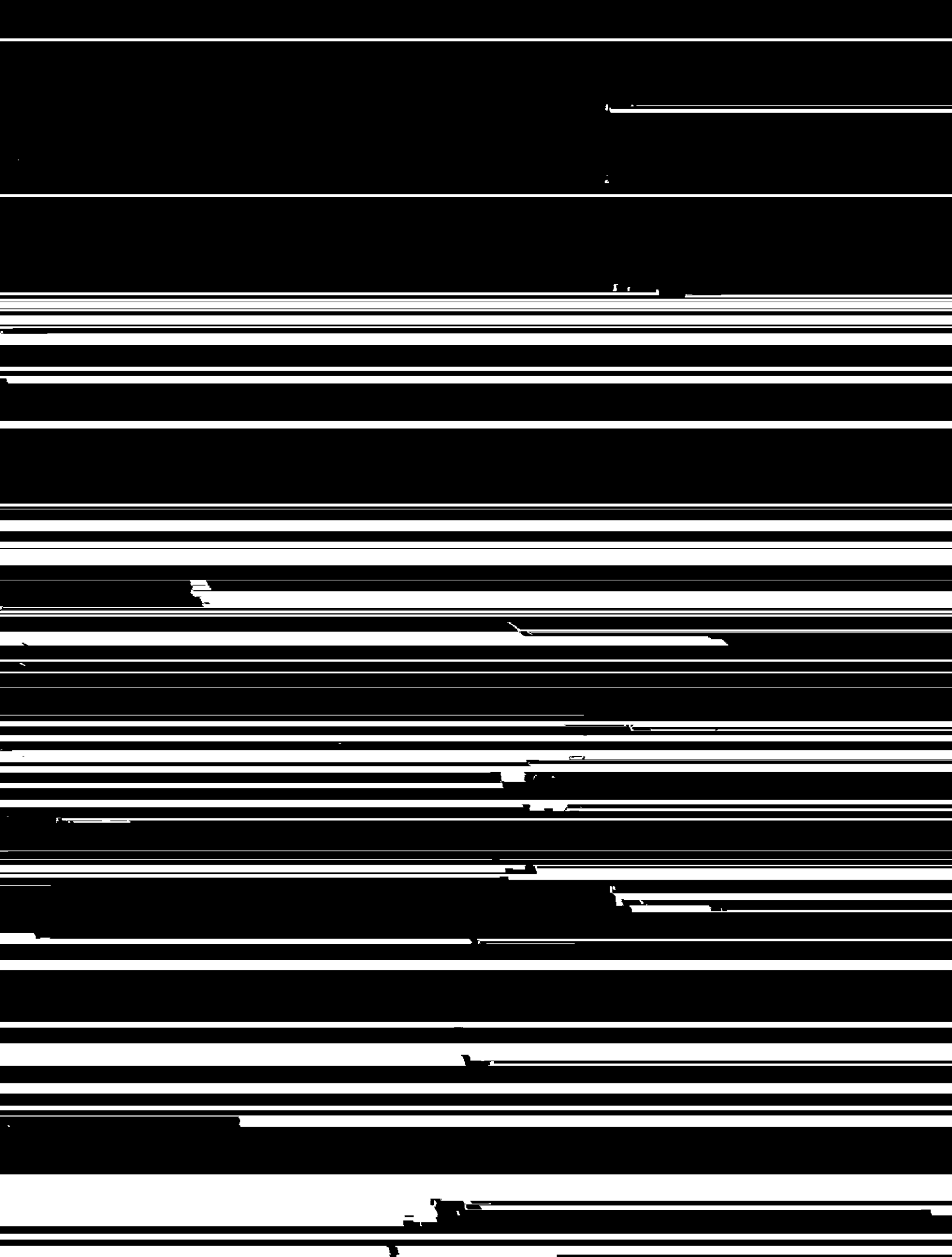


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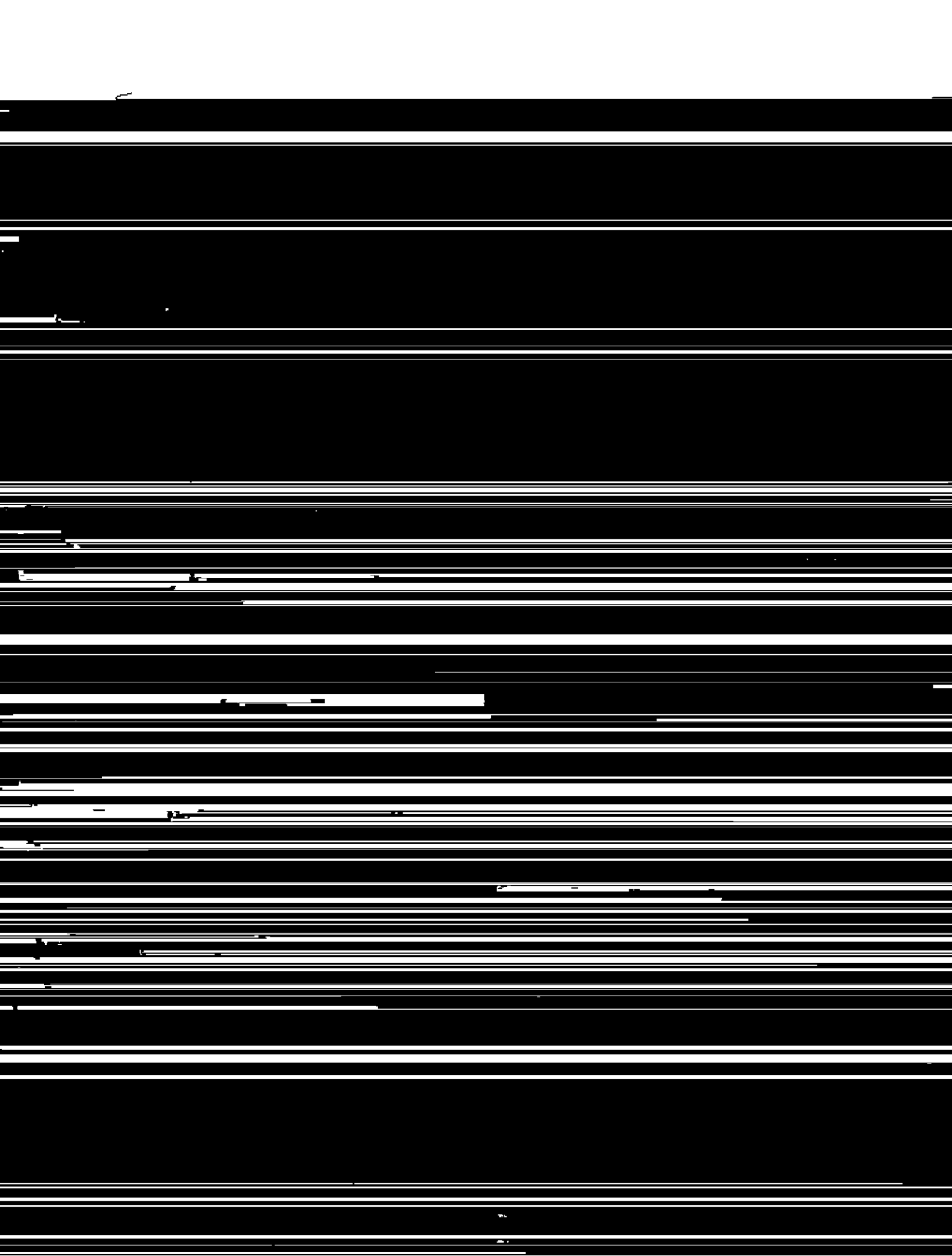
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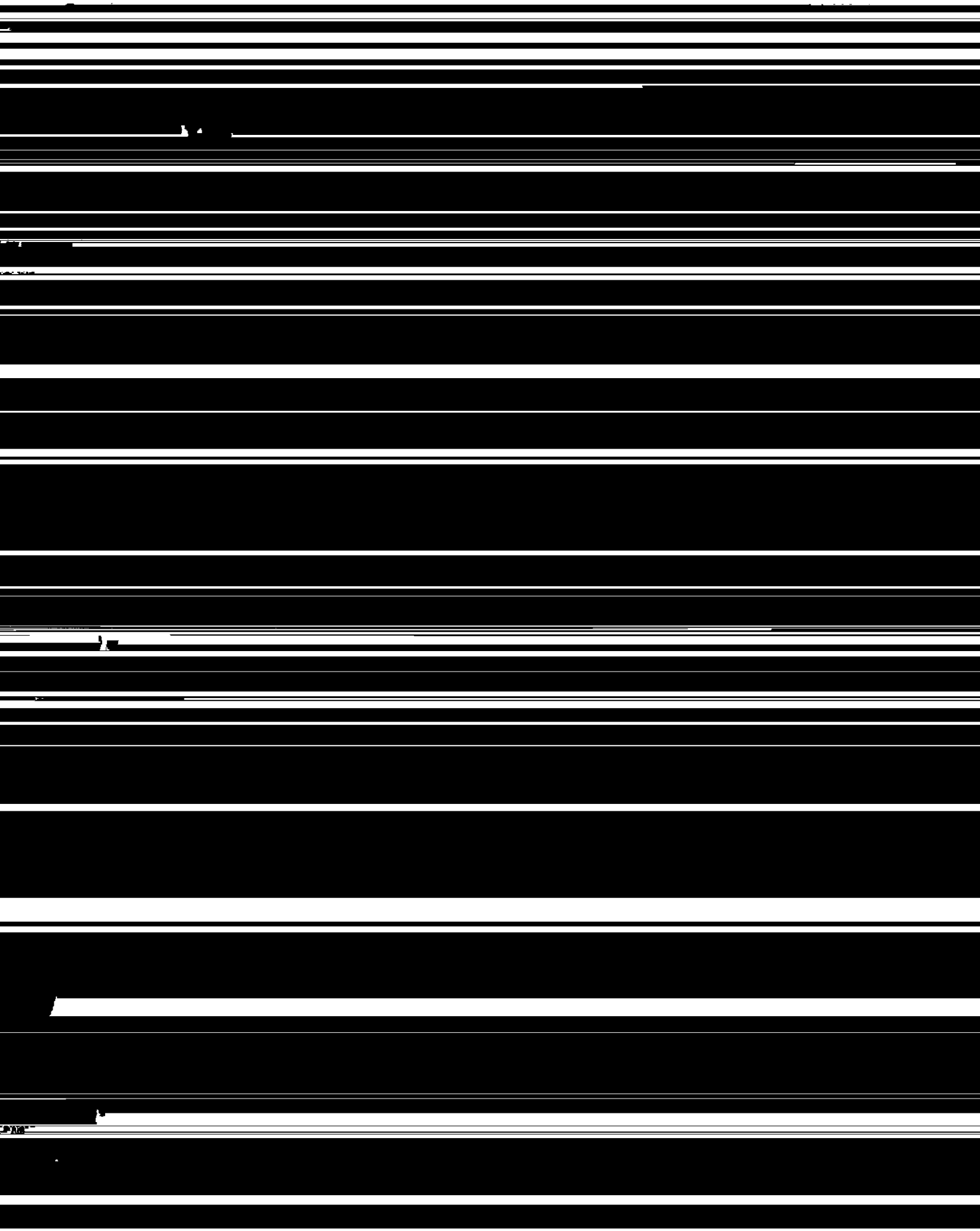
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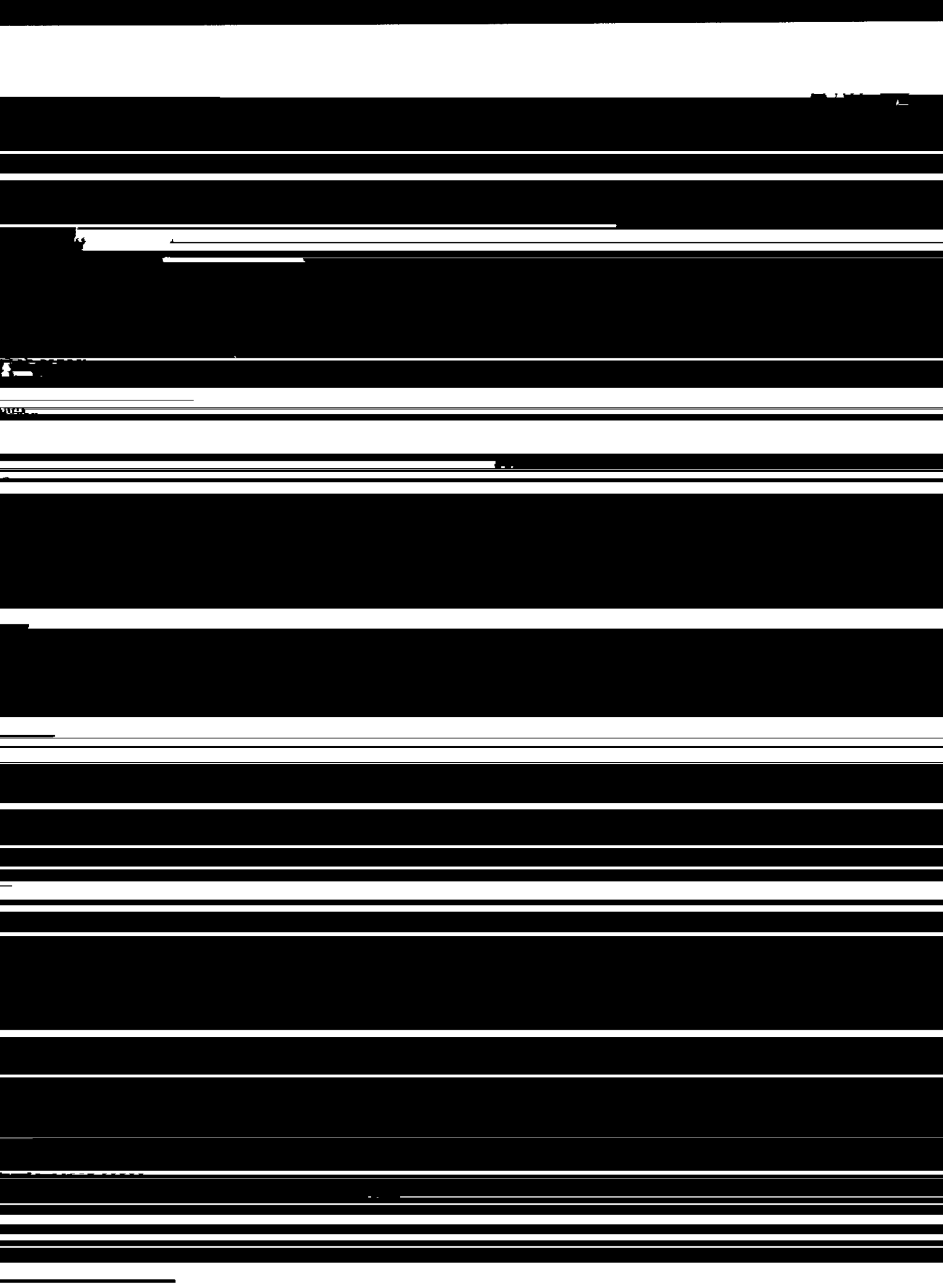




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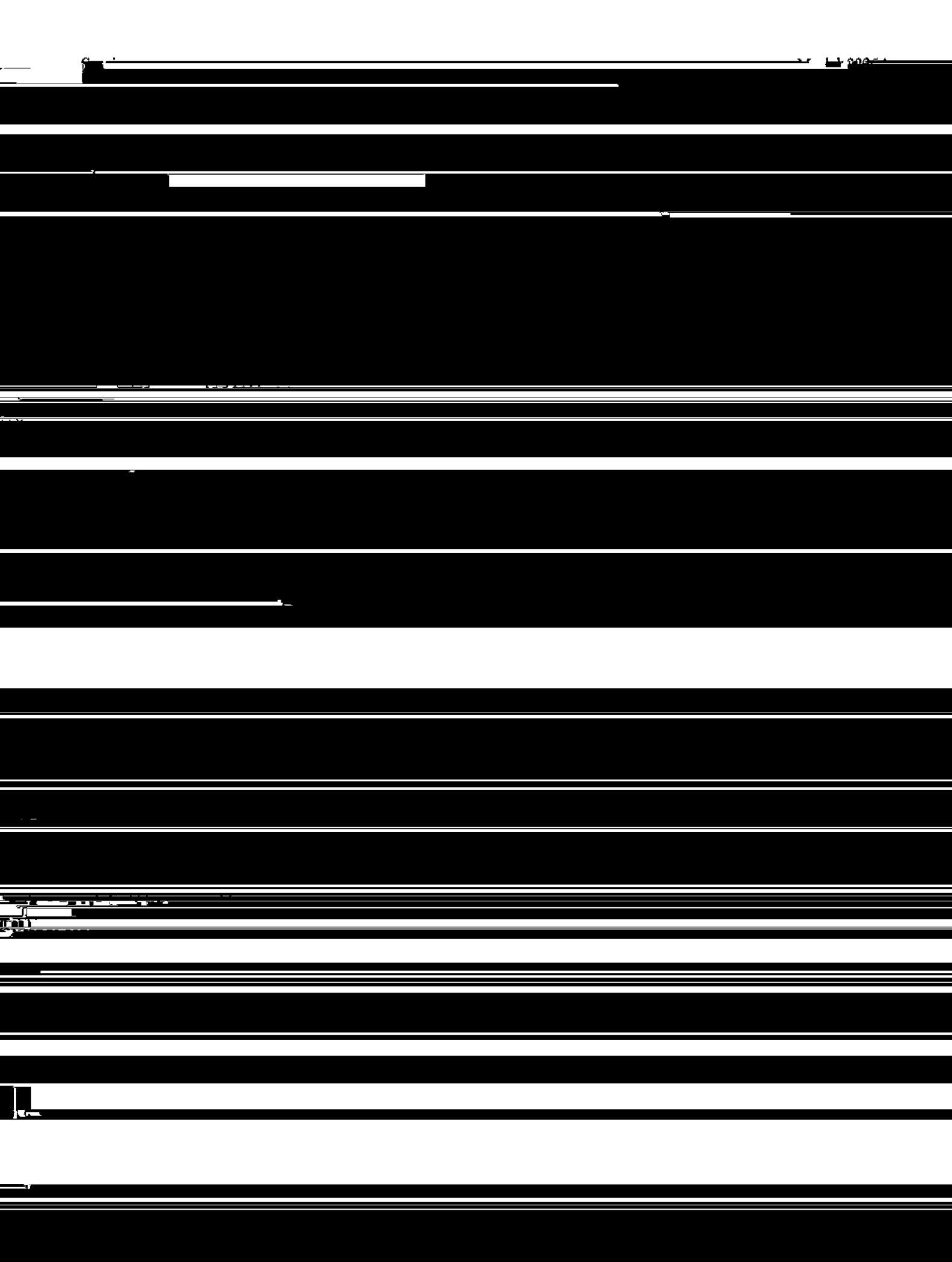
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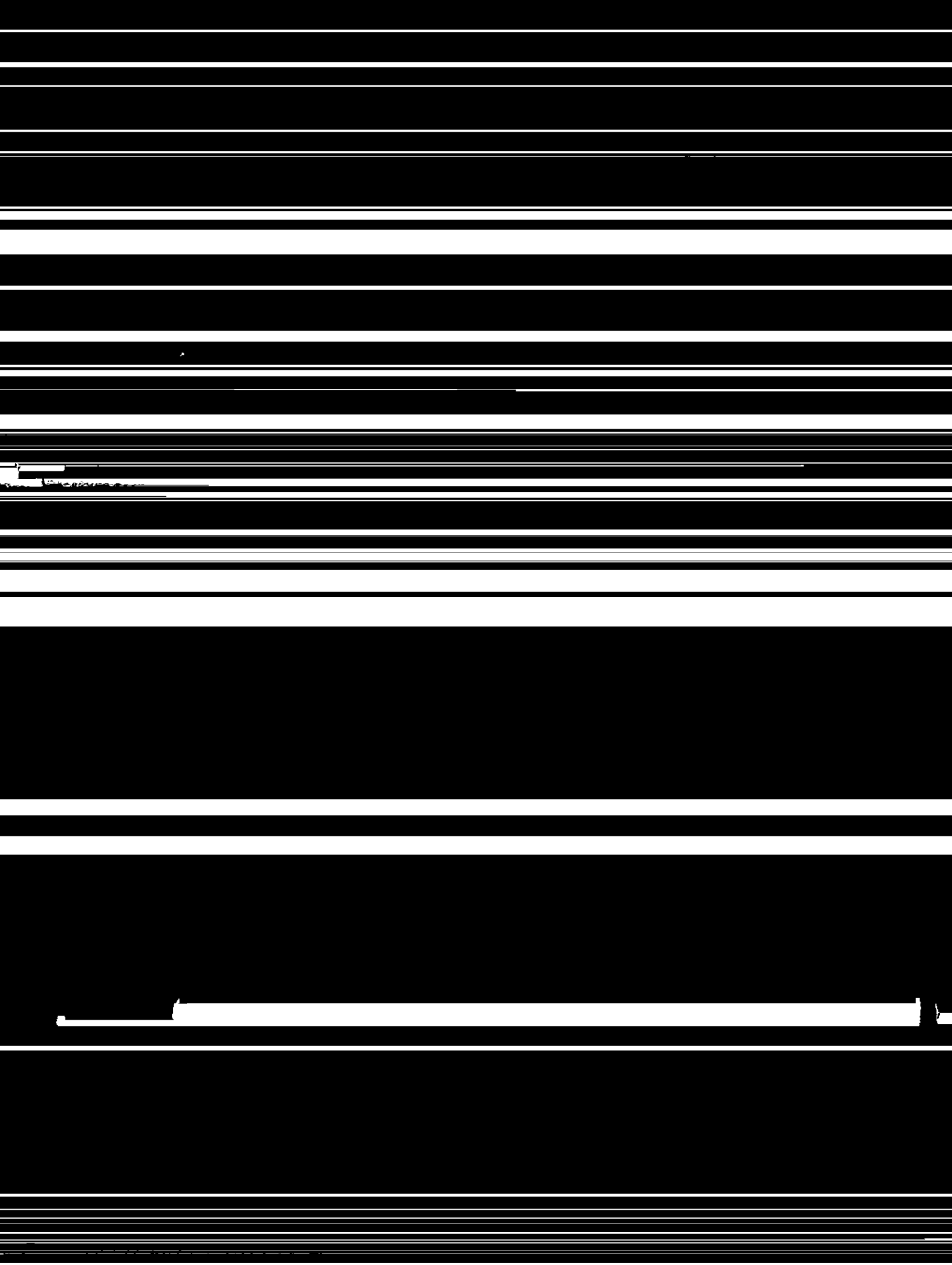
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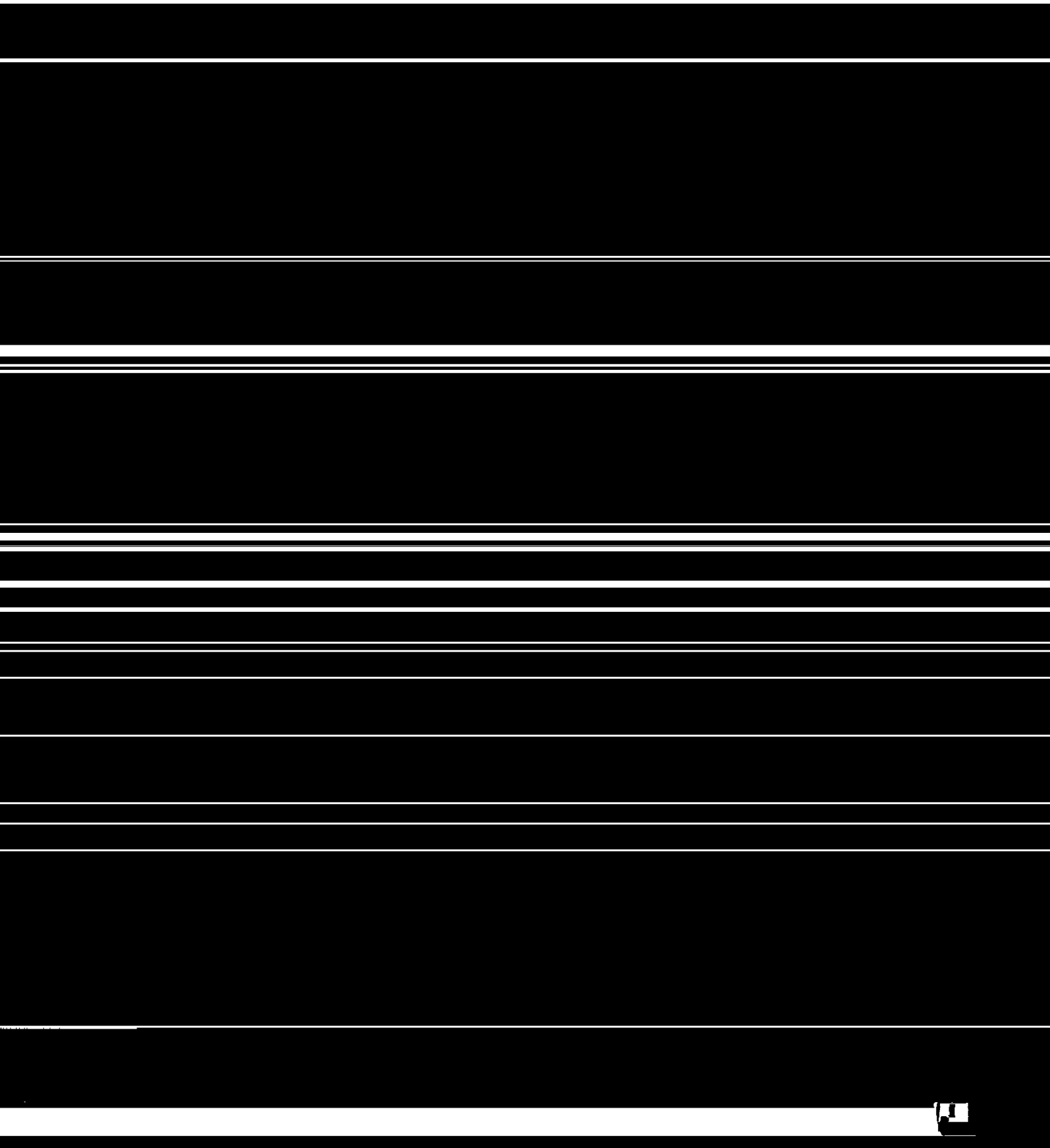


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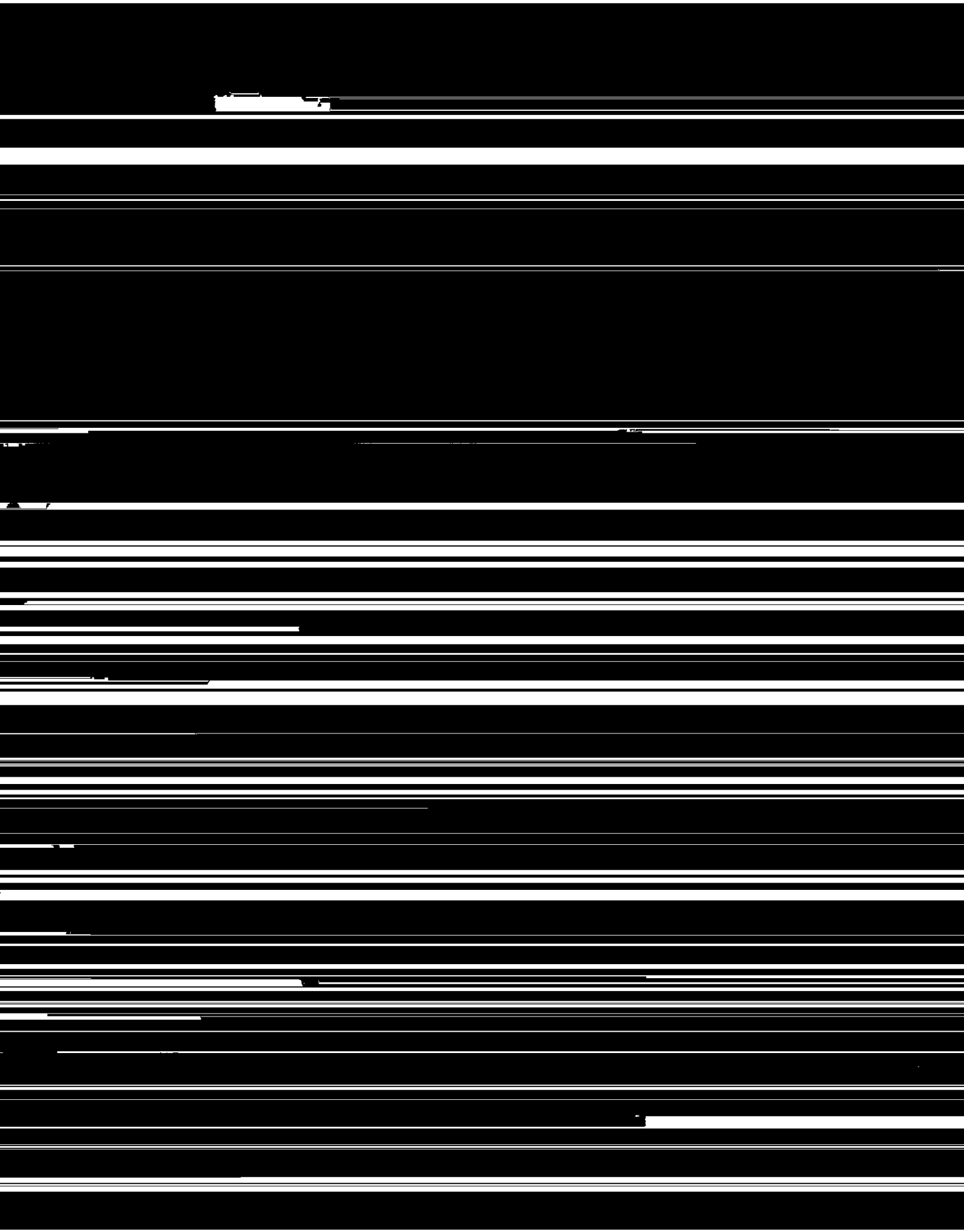


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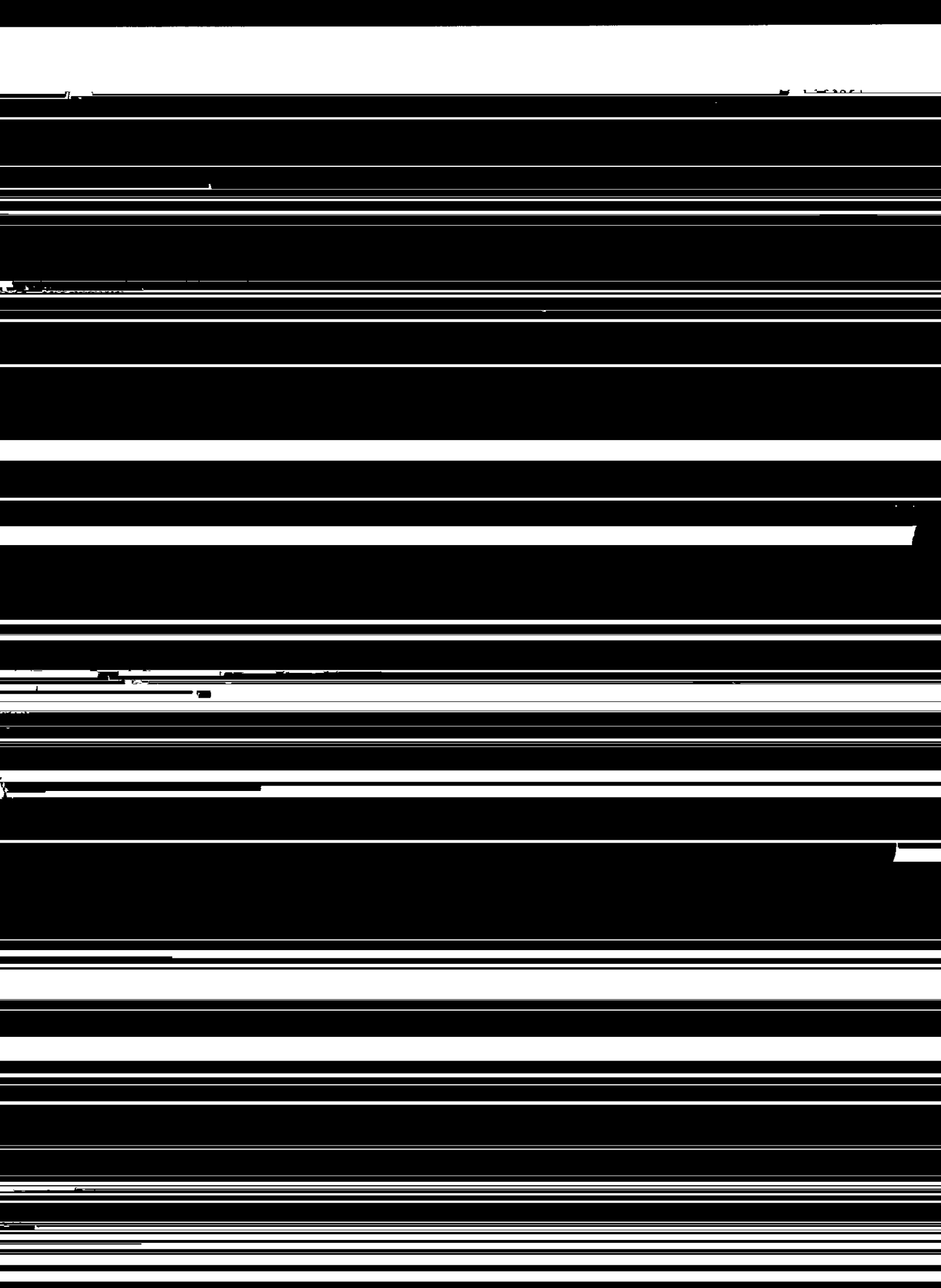




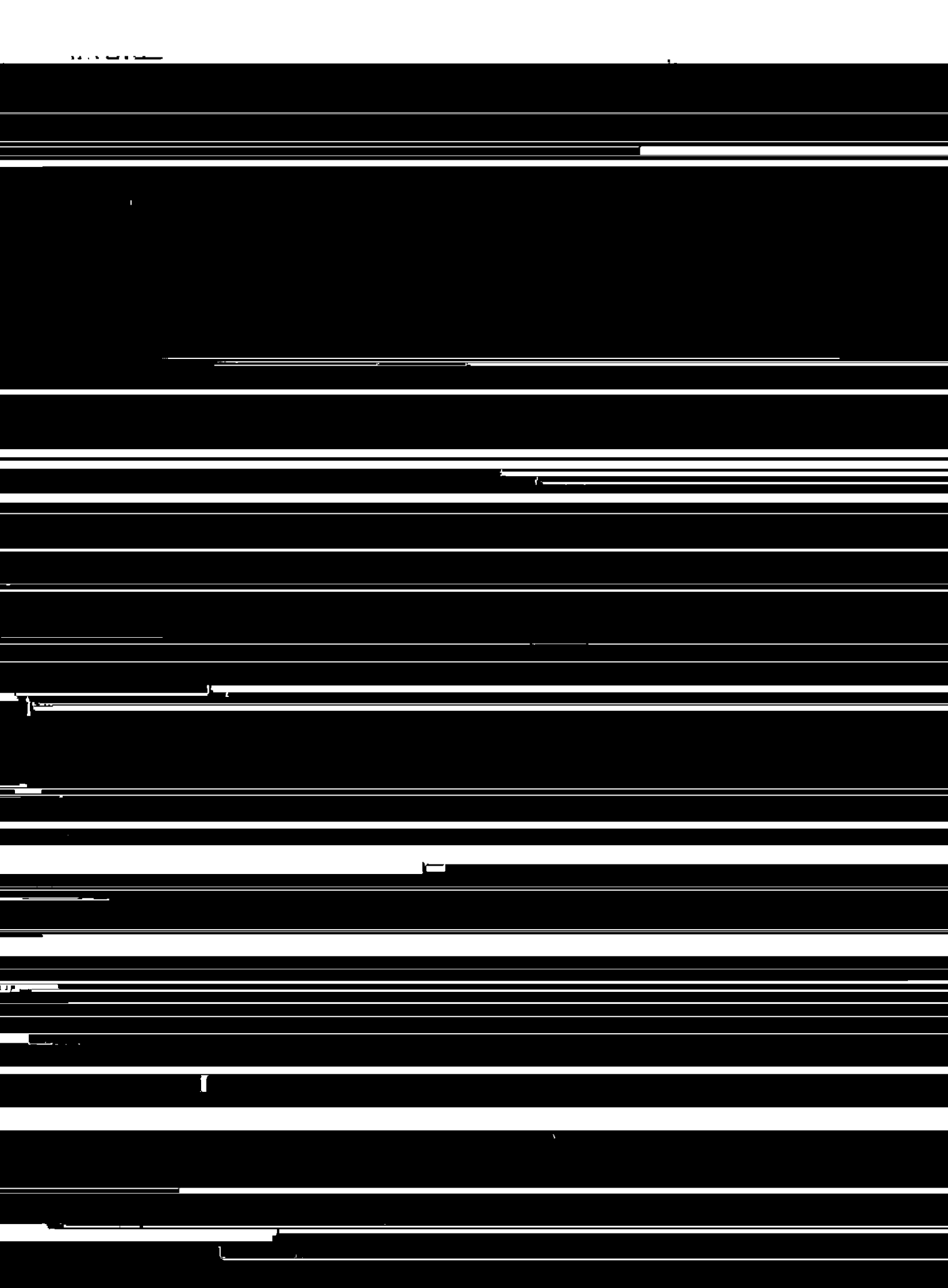
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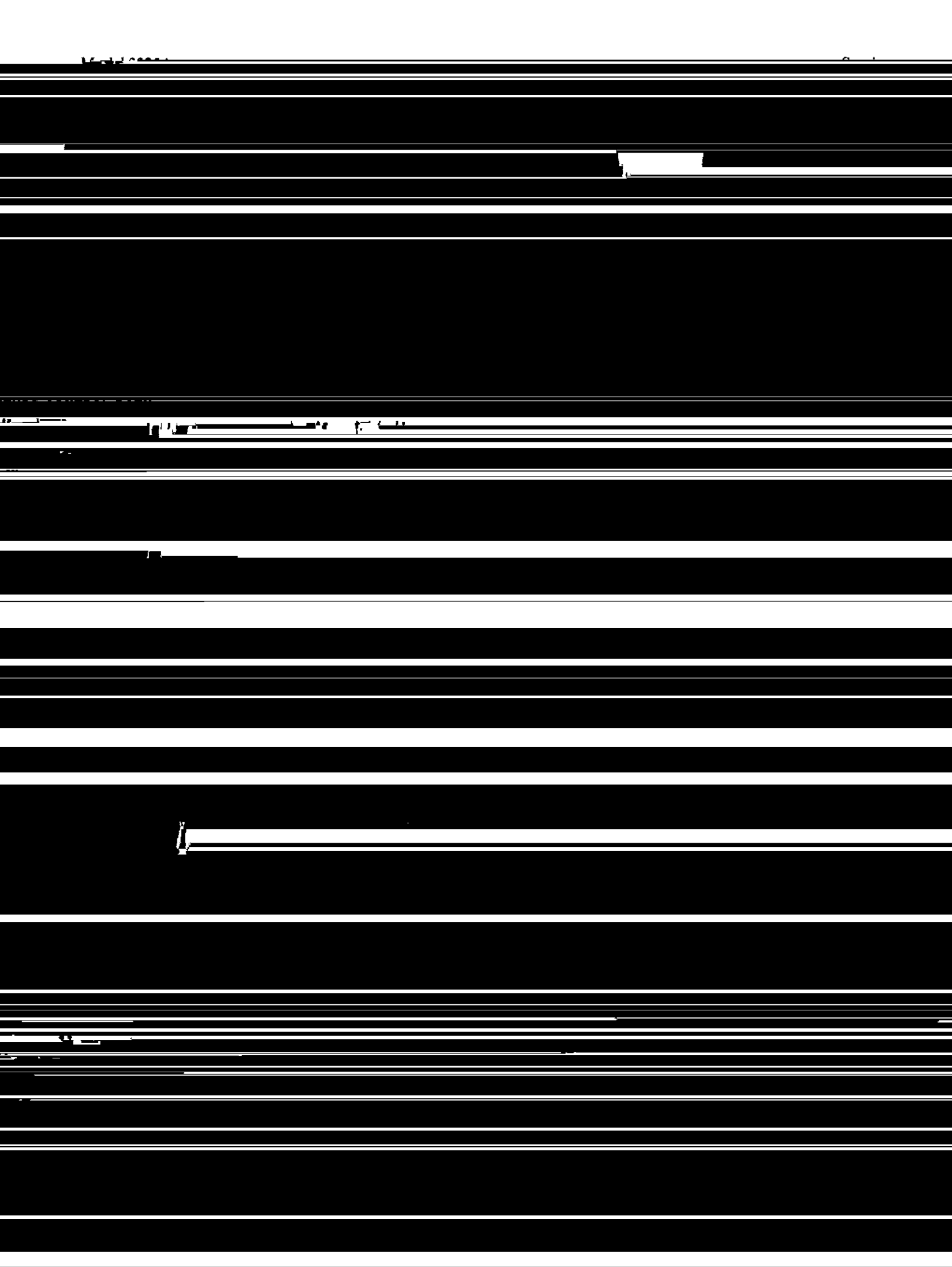






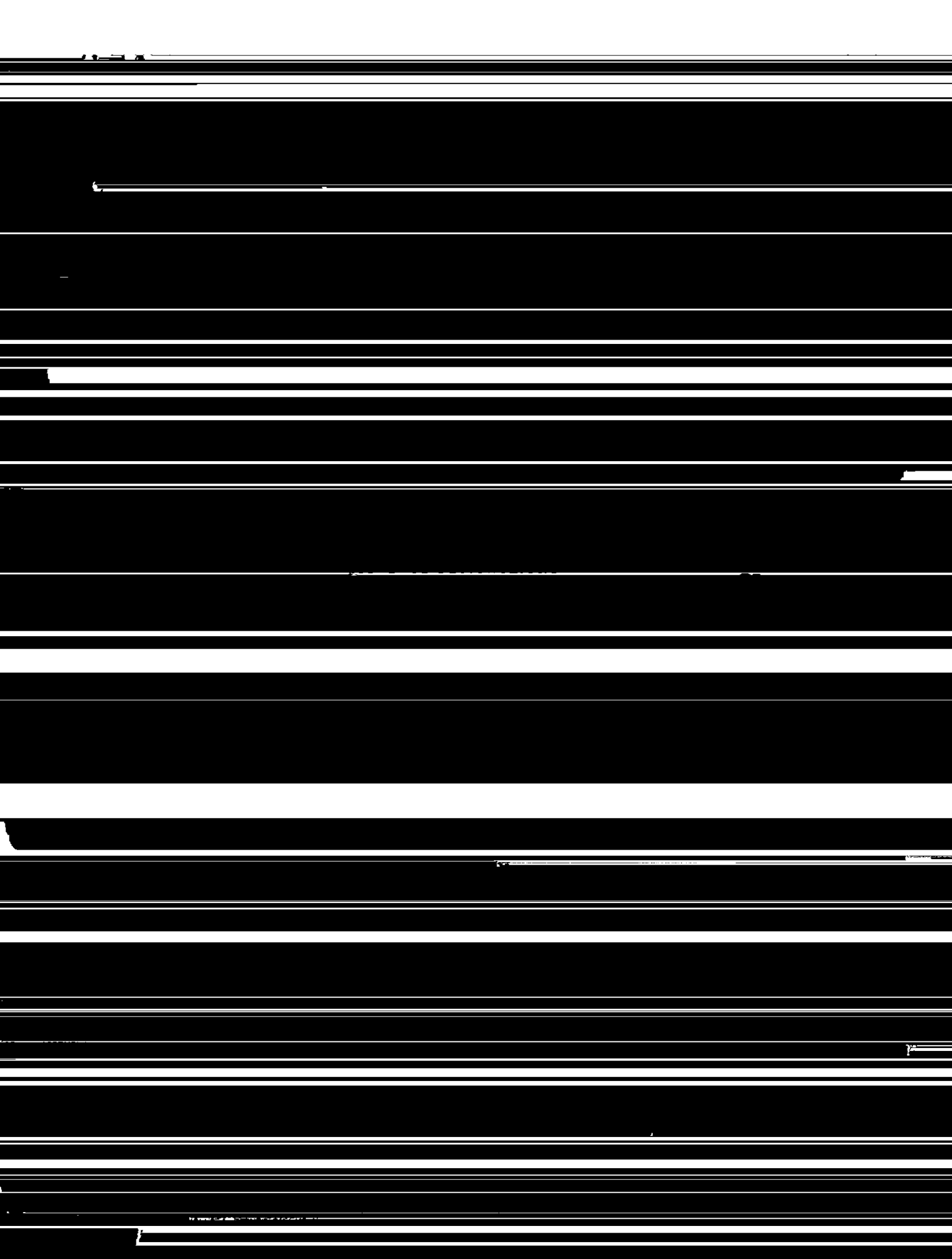
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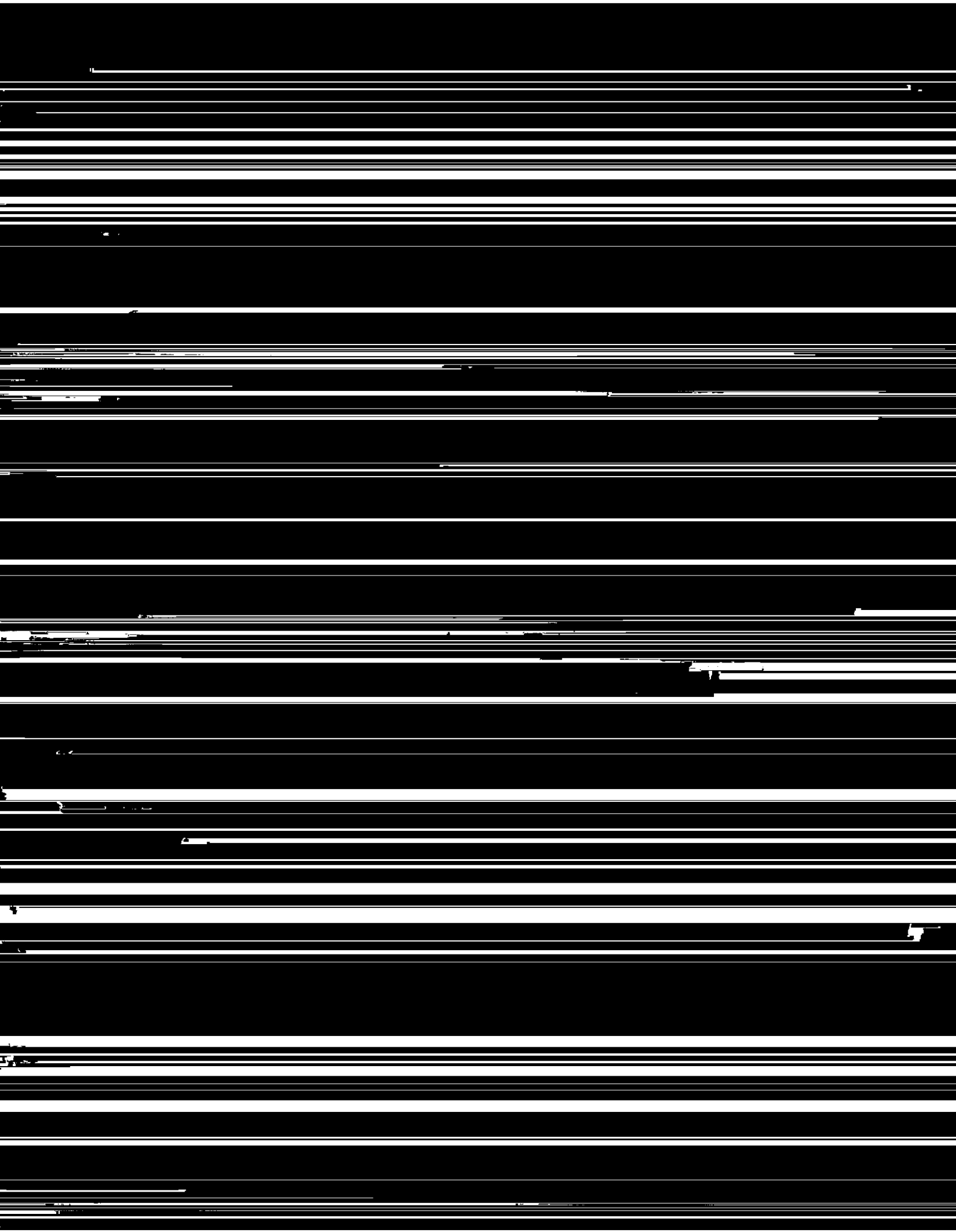


Fig 8-30 Sht 4 of 4

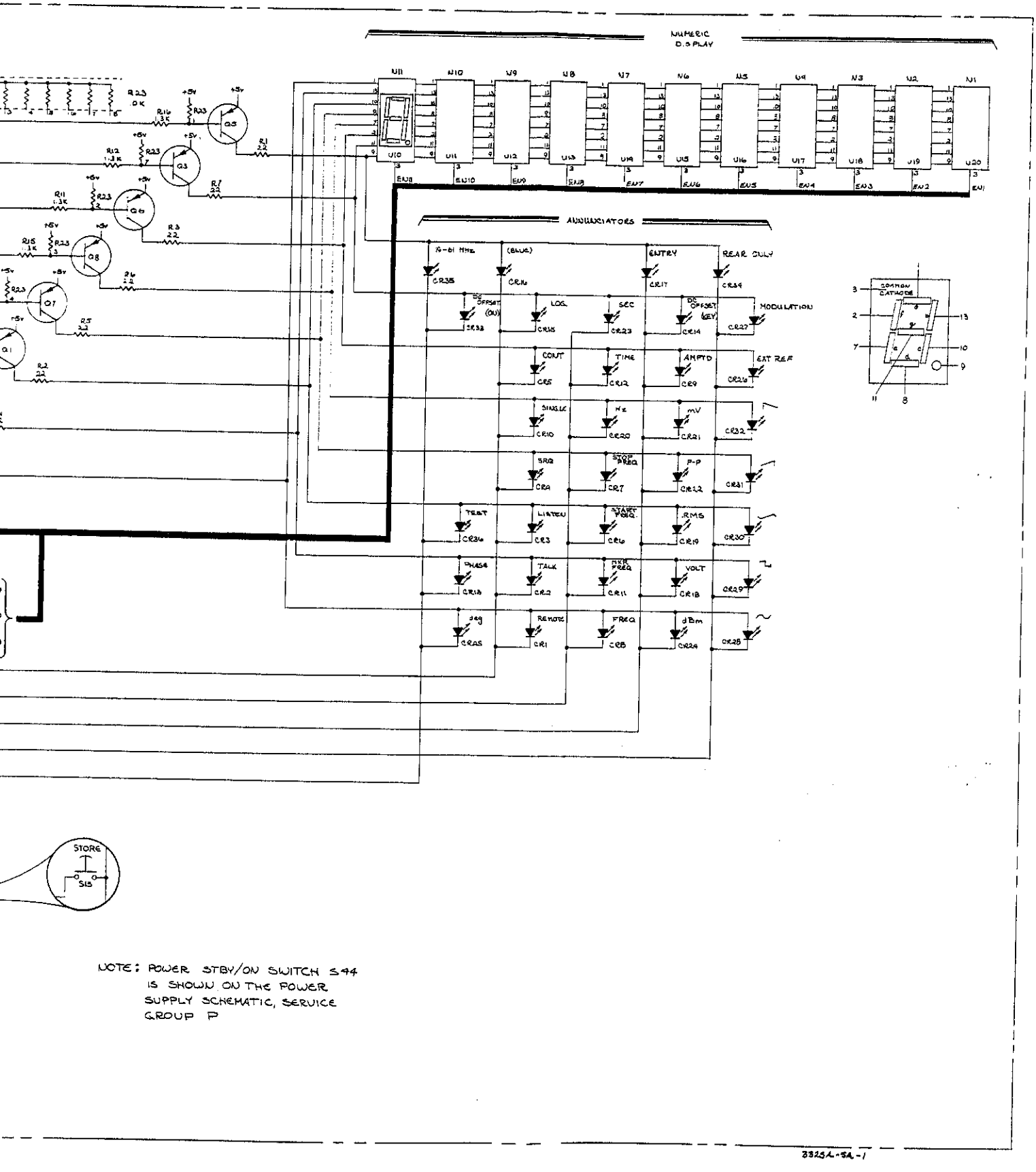
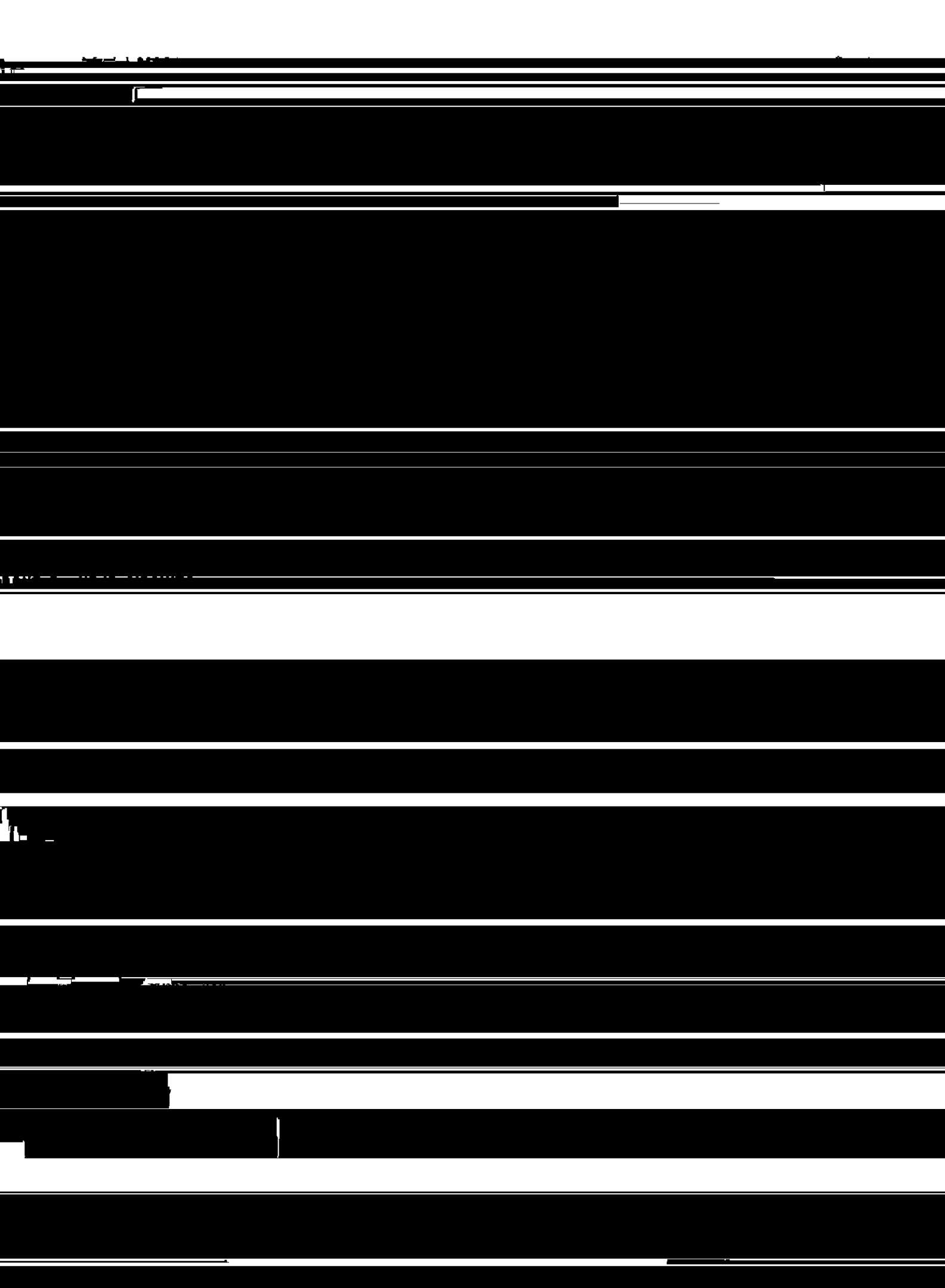


Figure 8-30. Keyboard and Display, A5.
8-A-7/8-A-8



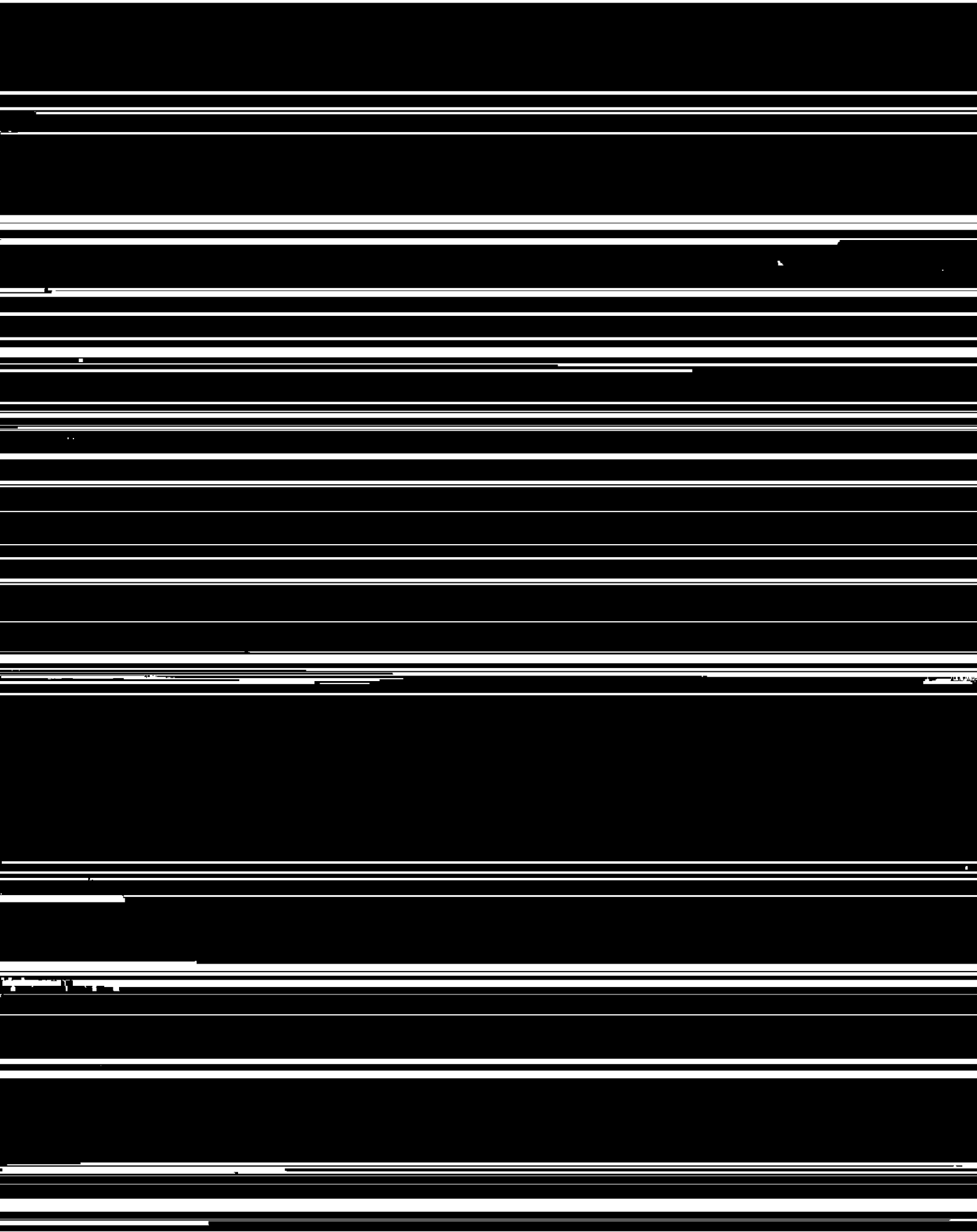
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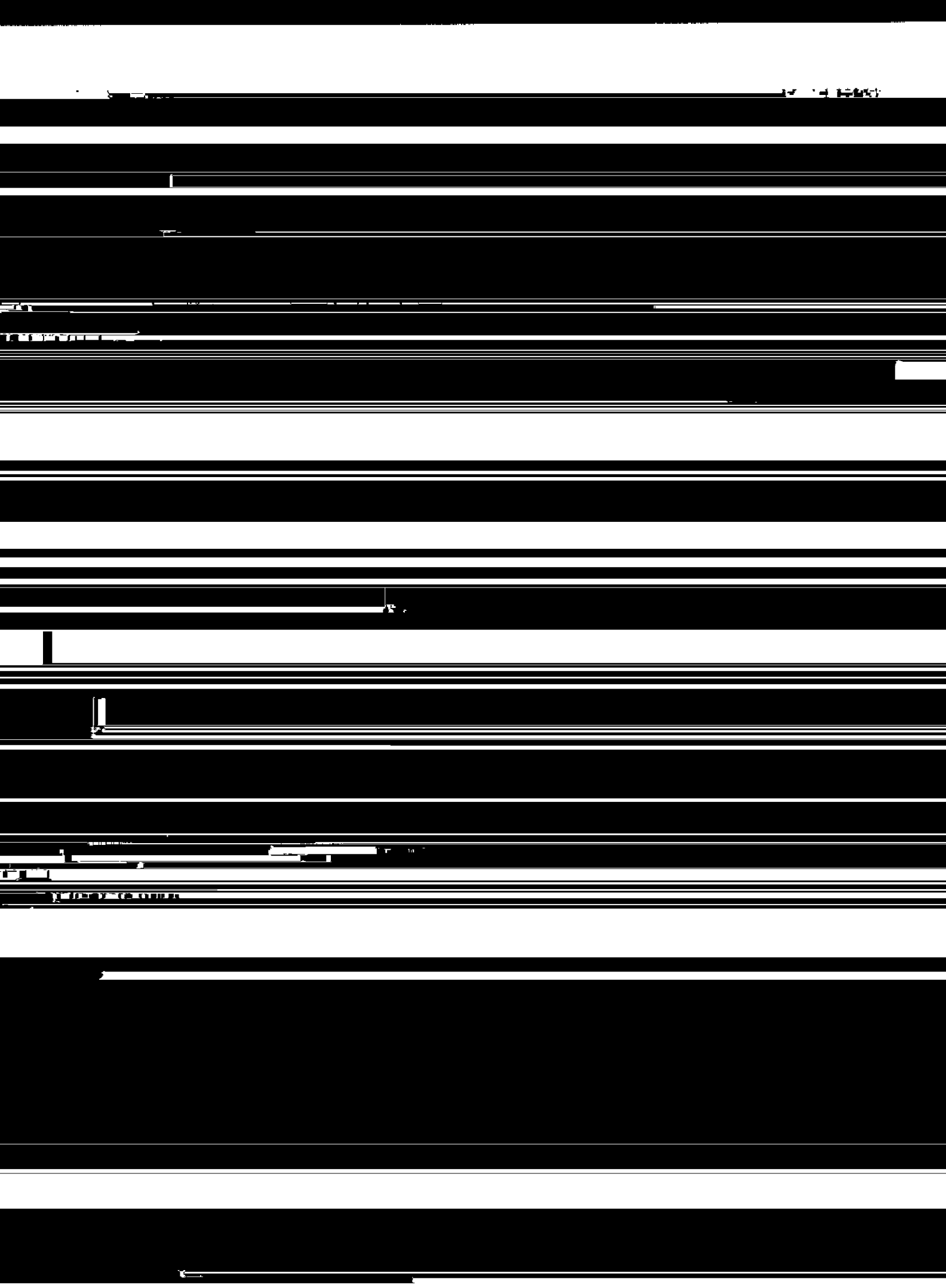


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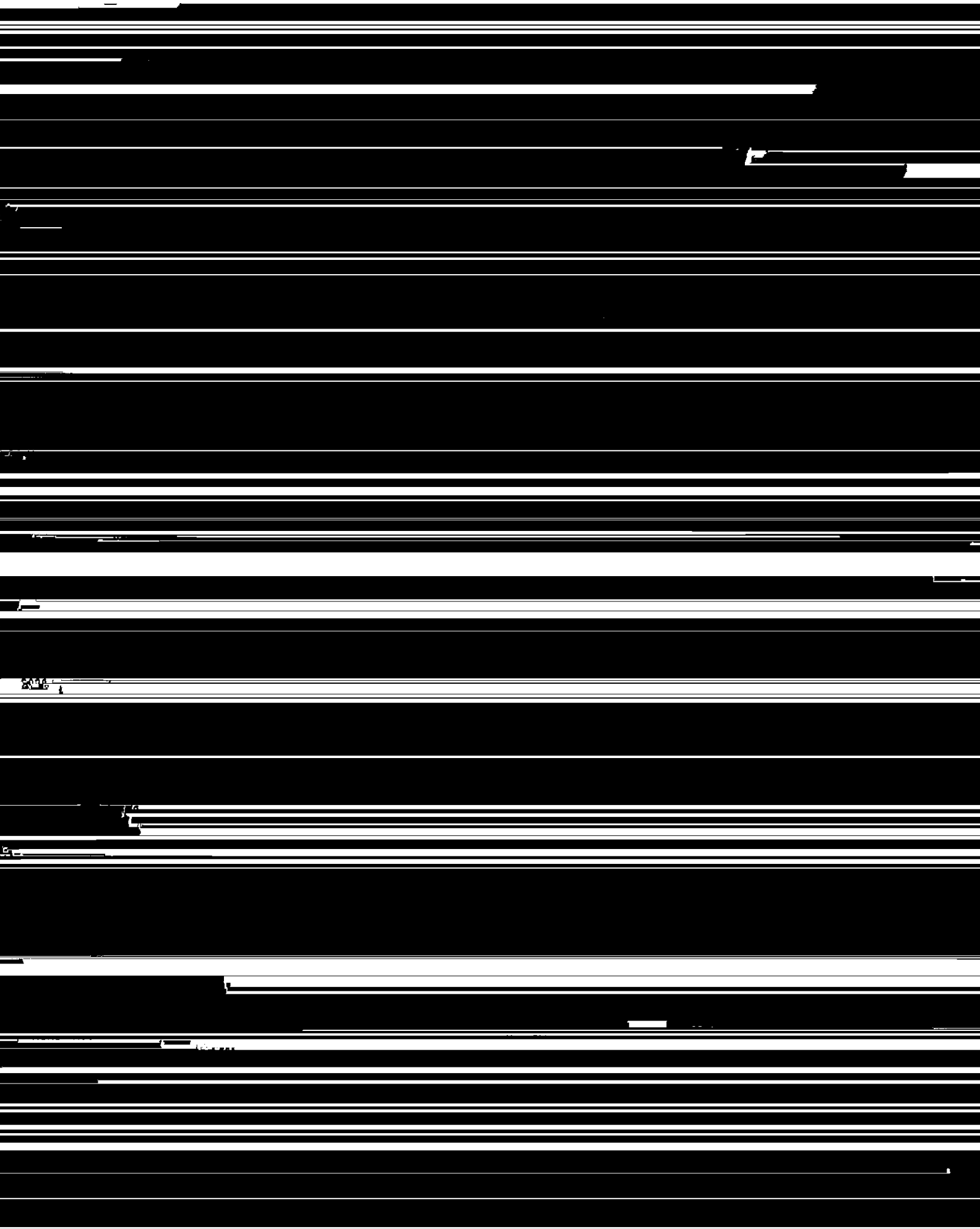
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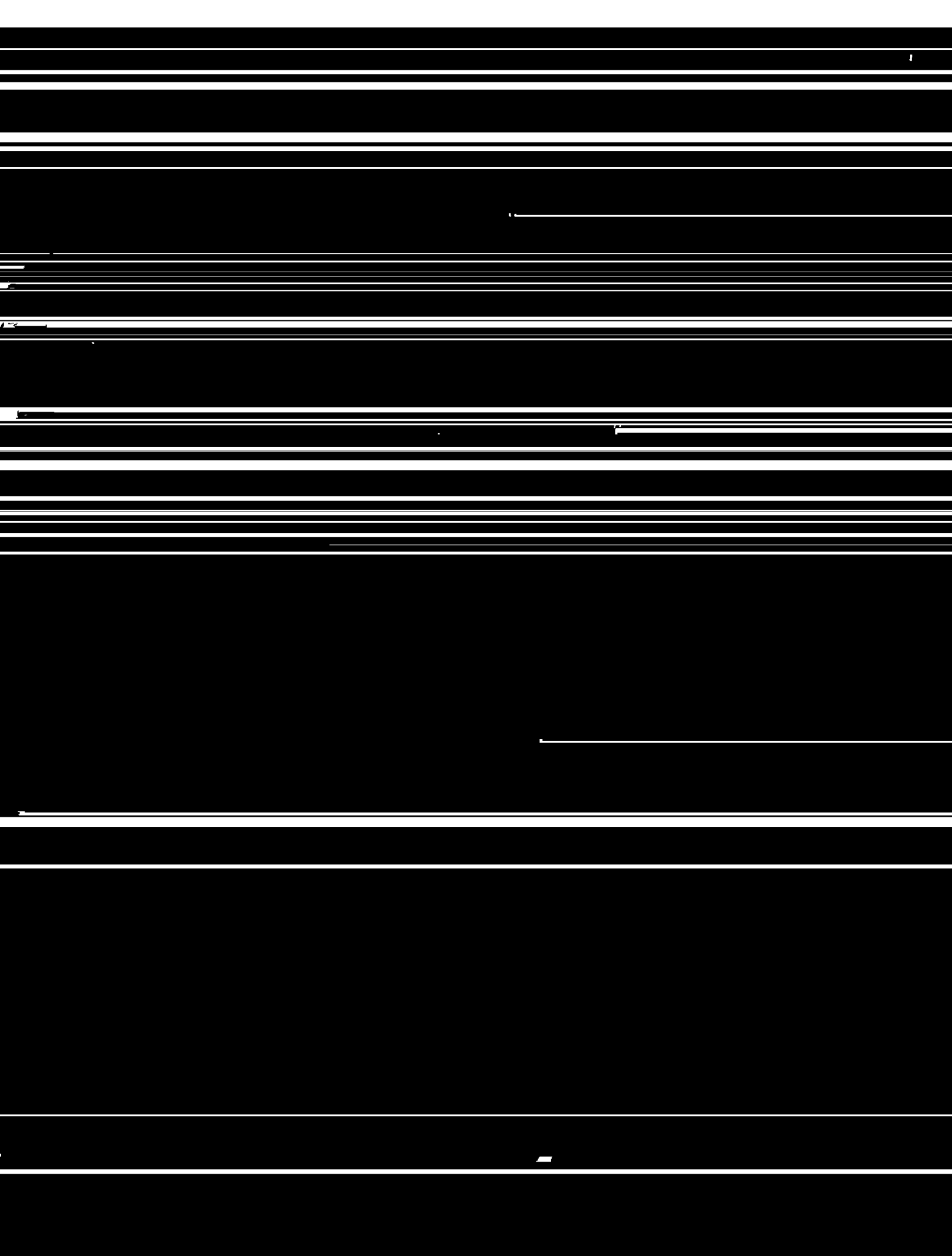


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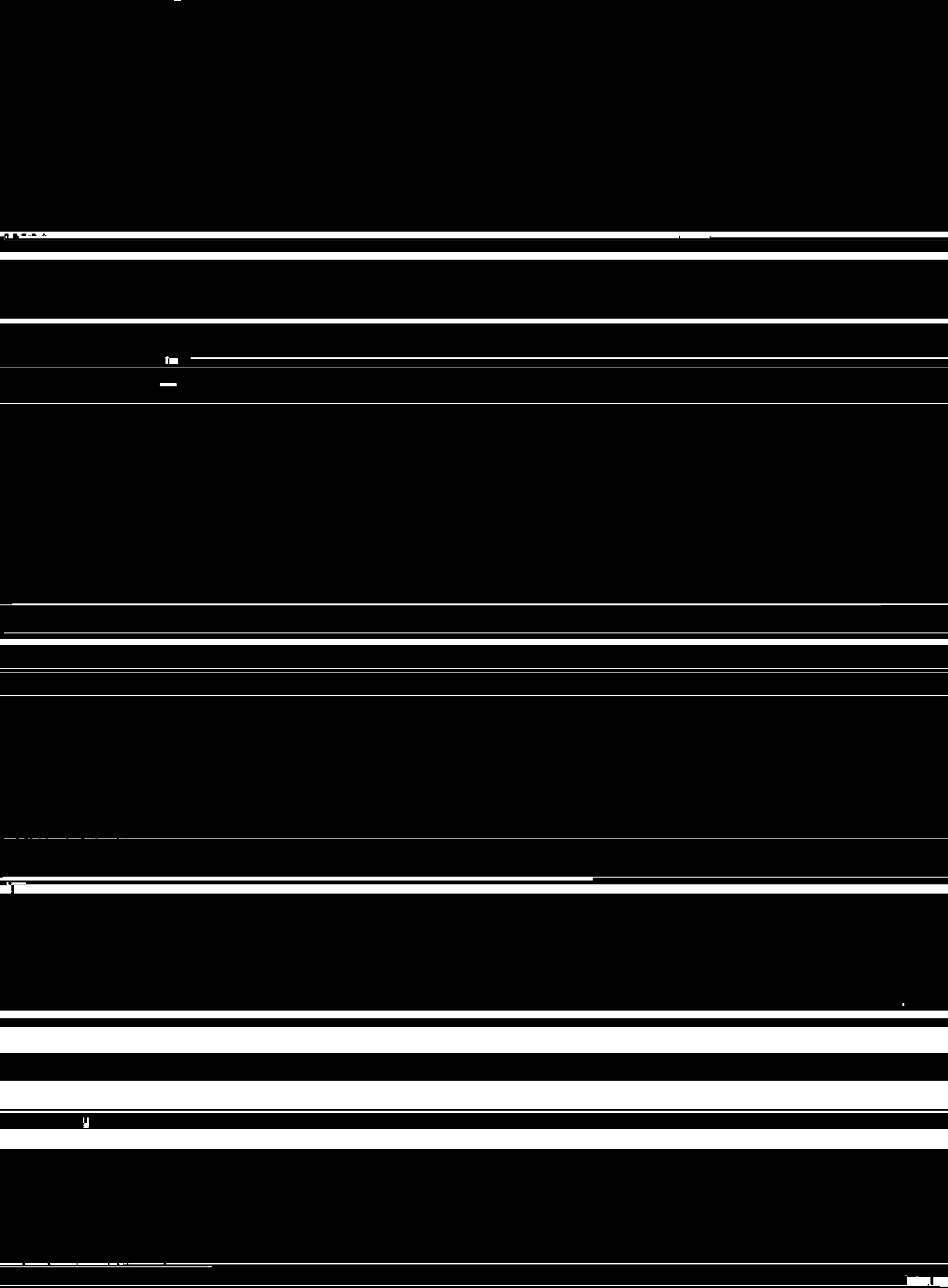
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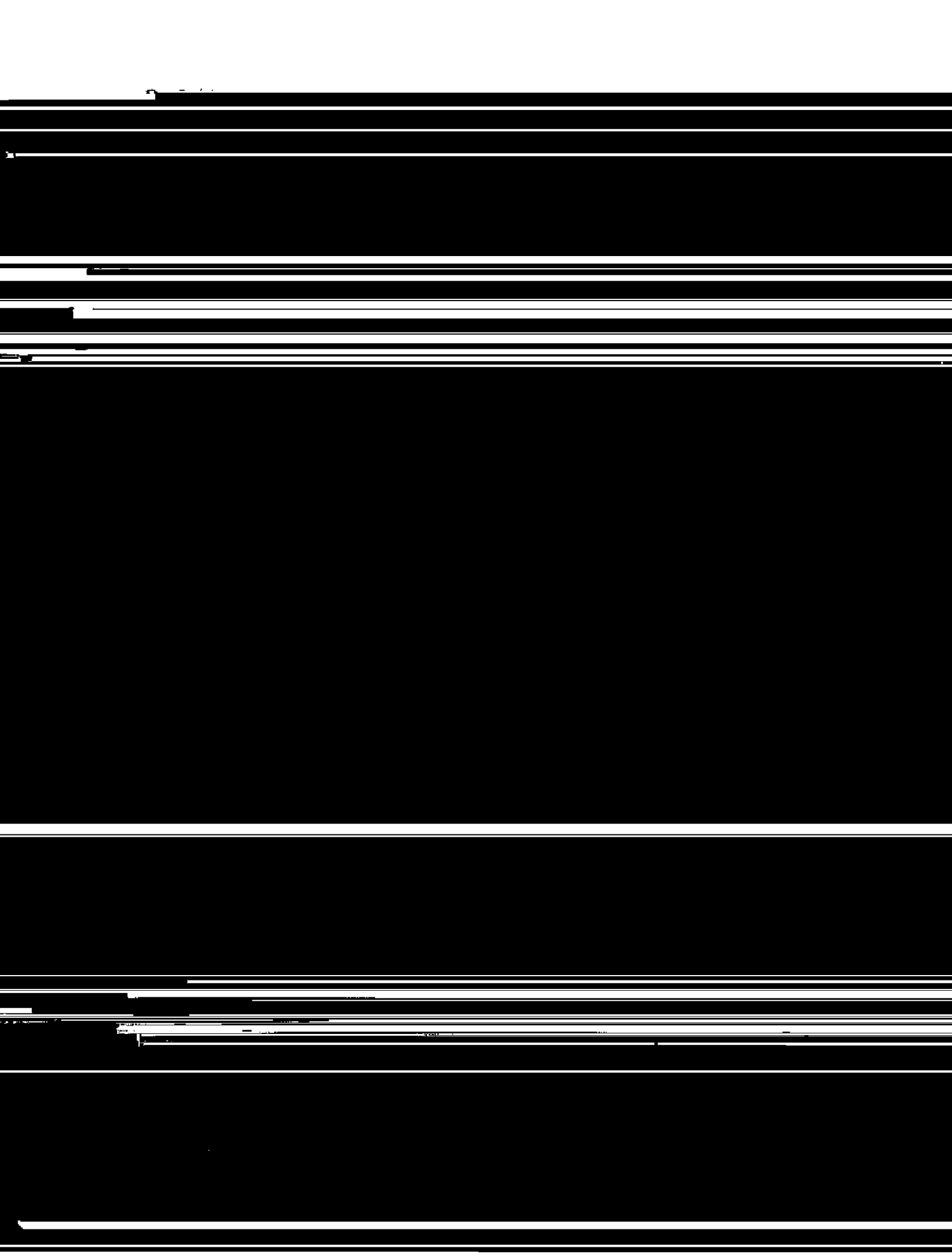




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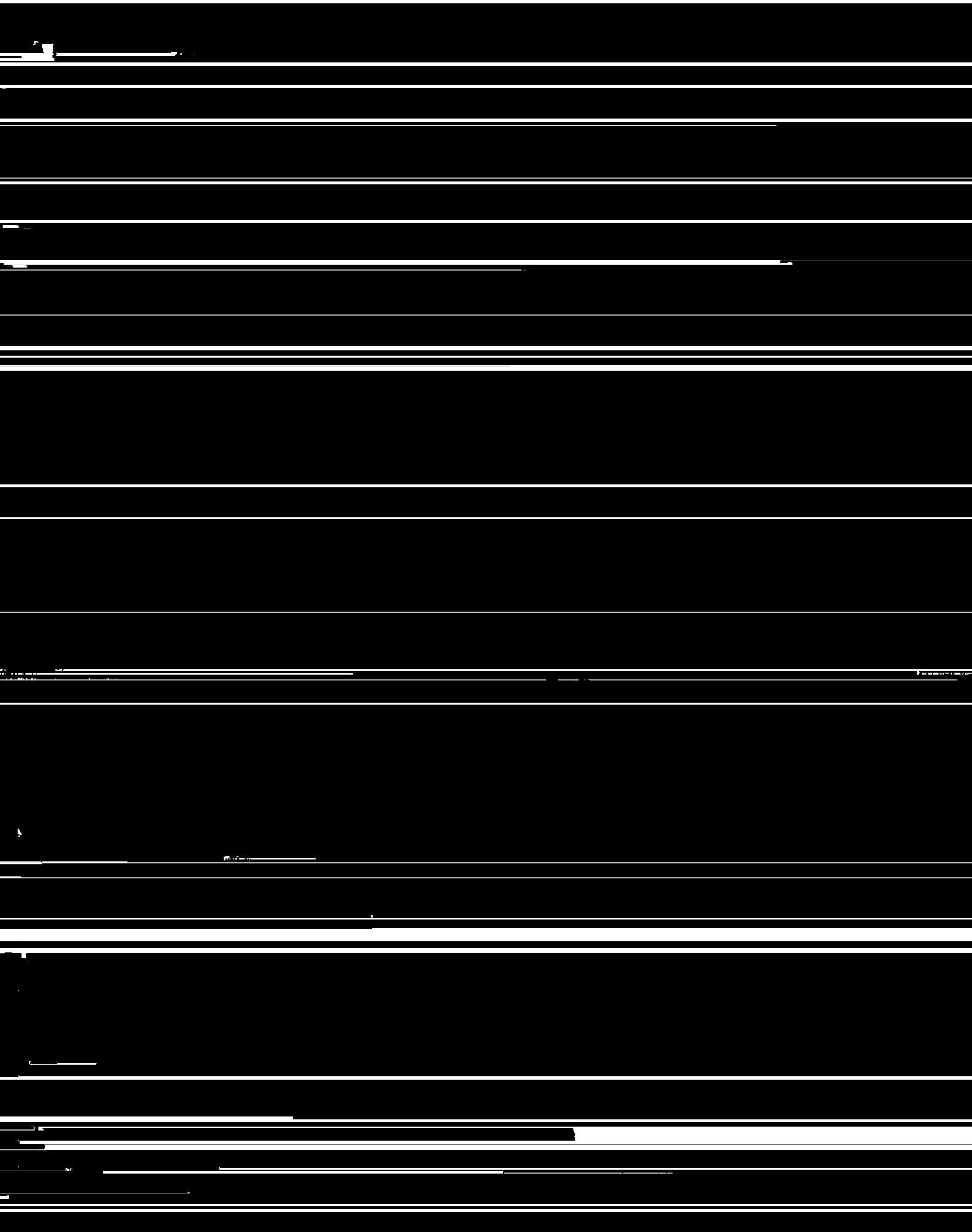


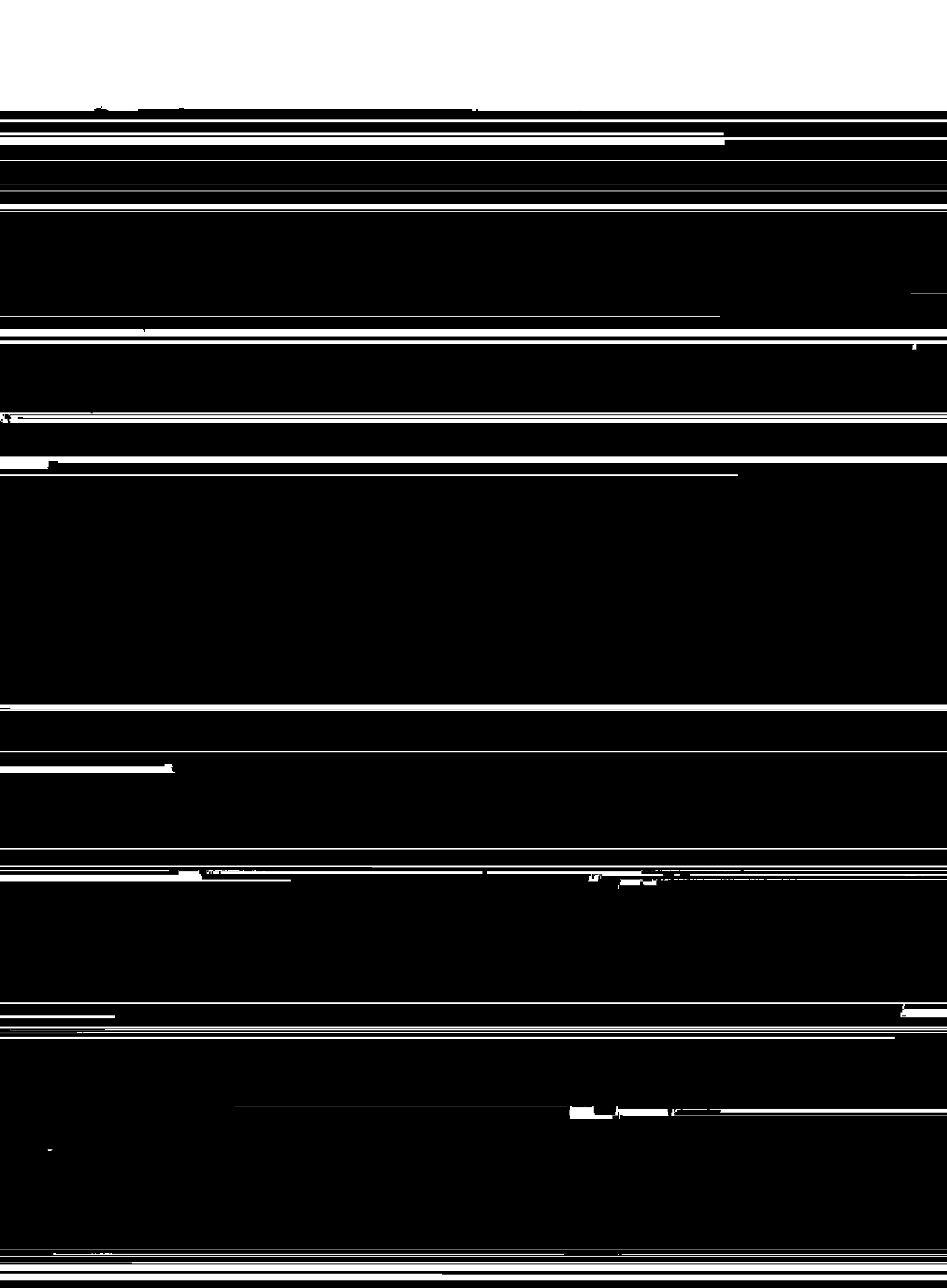
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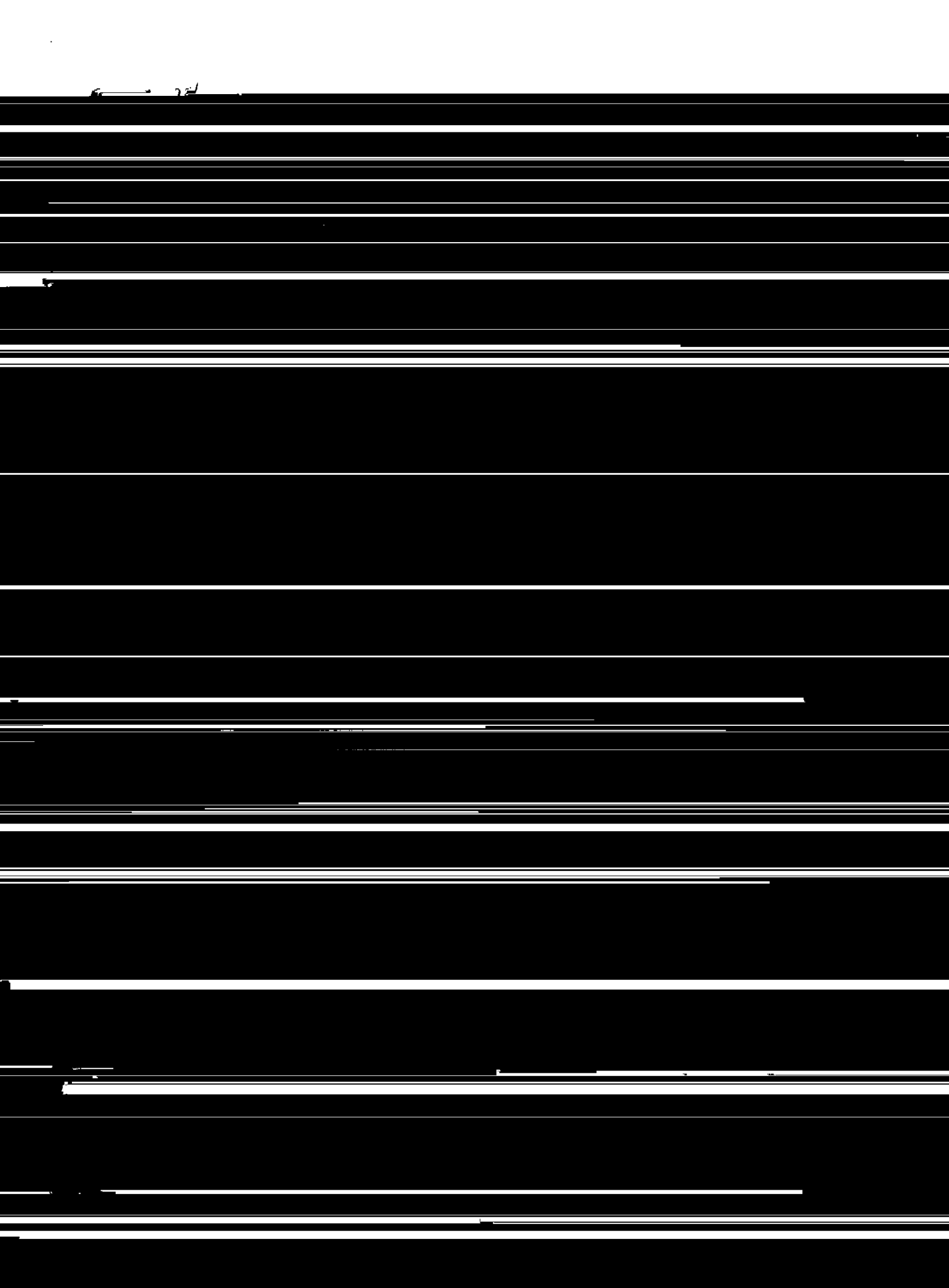


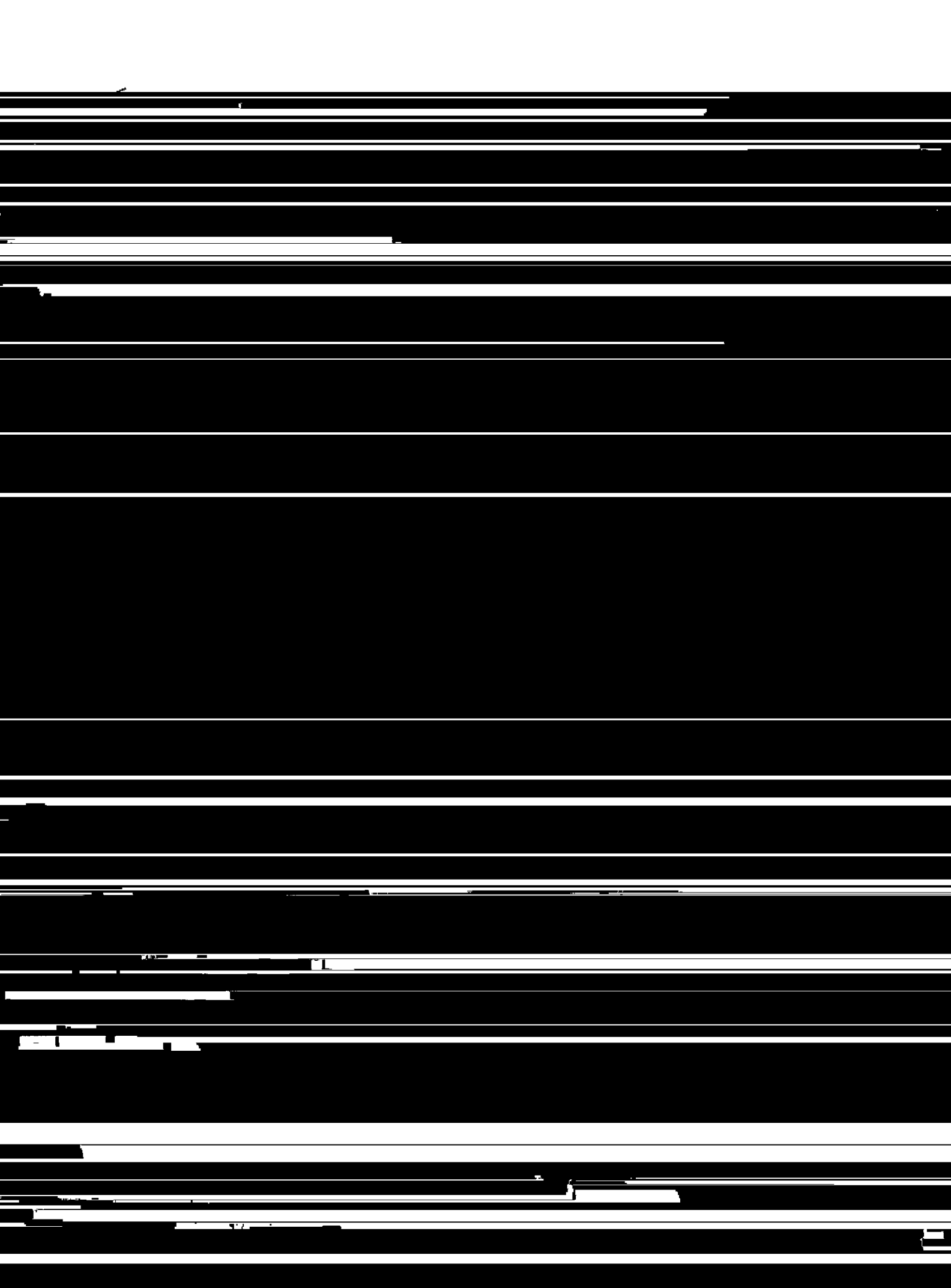
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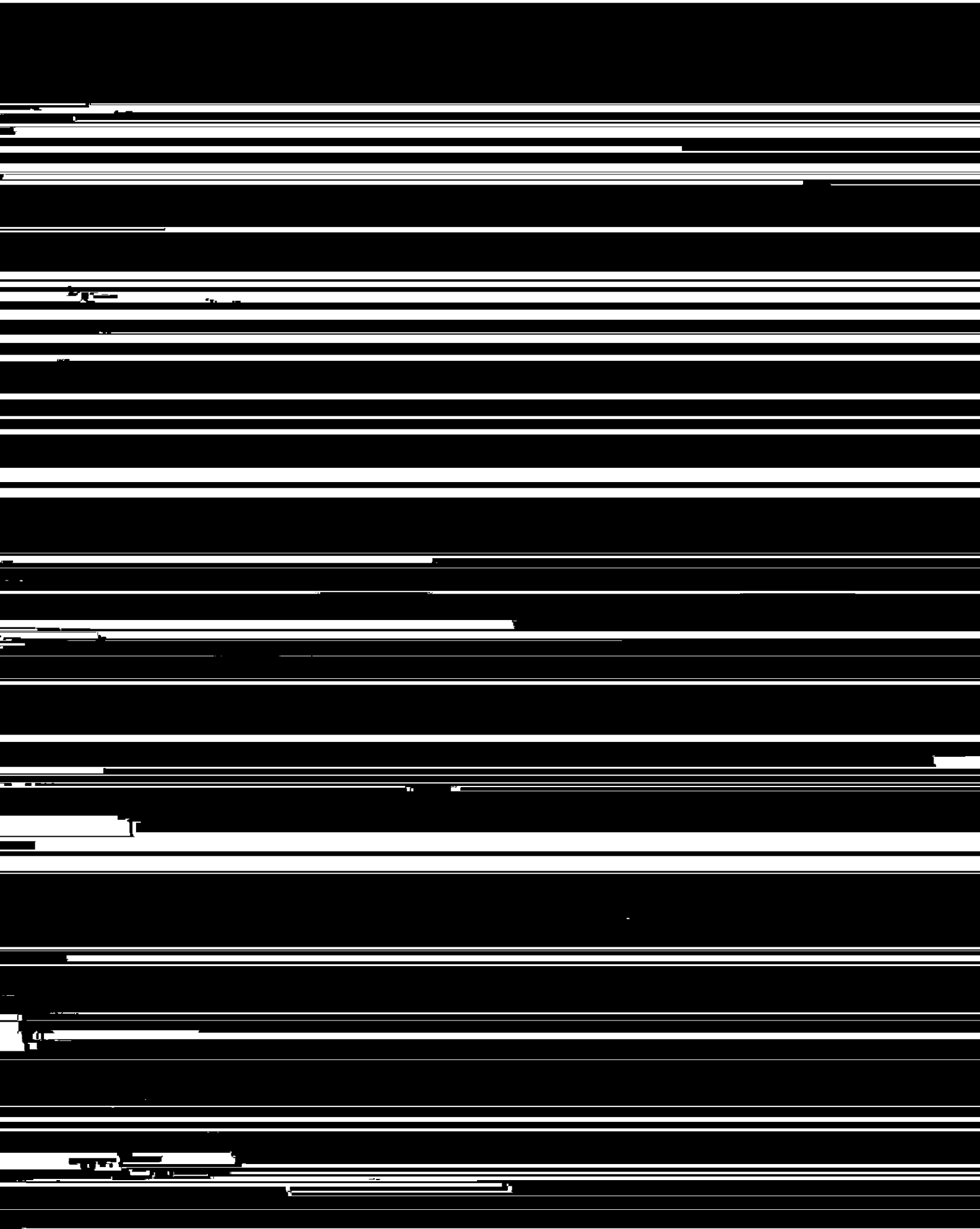
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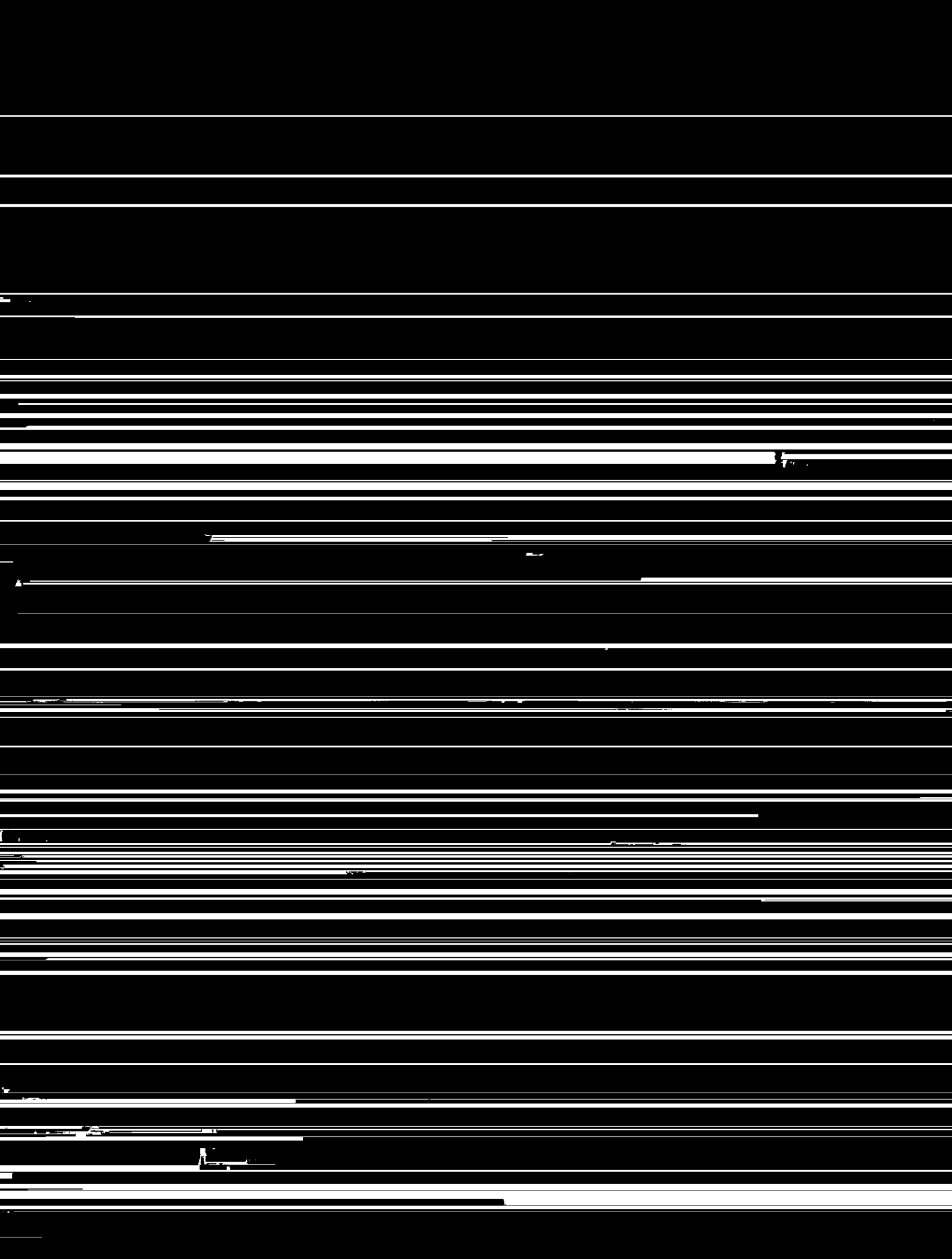




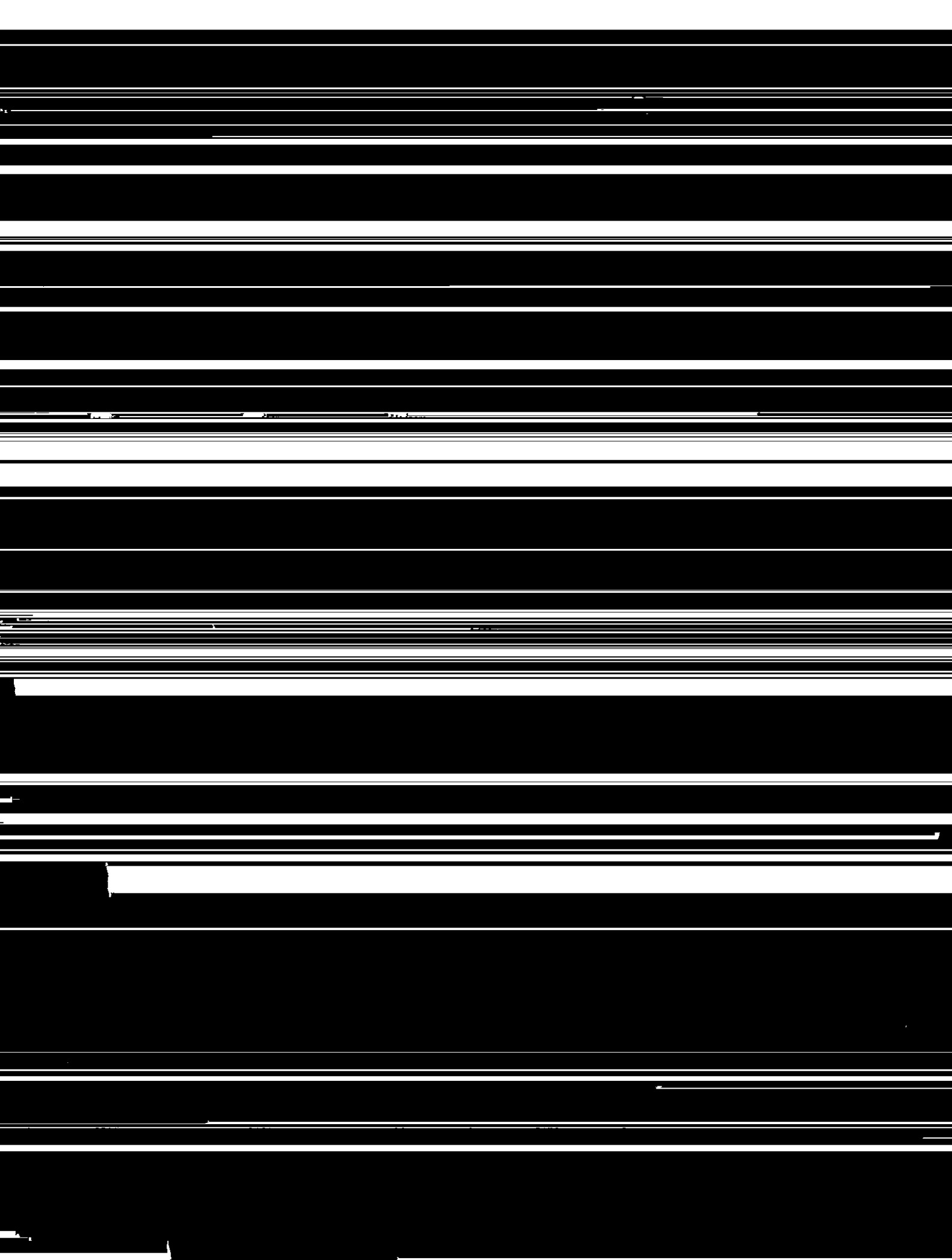


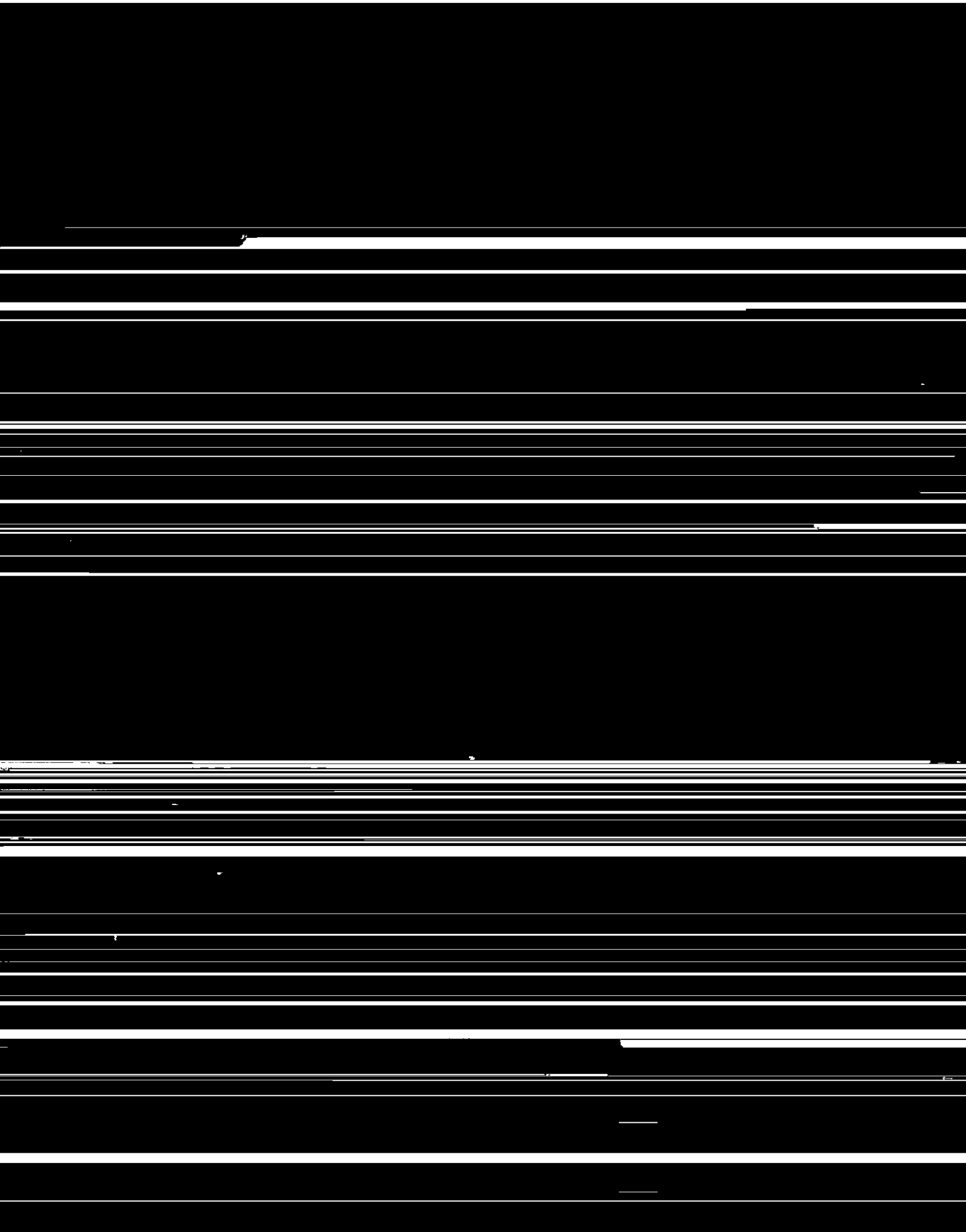




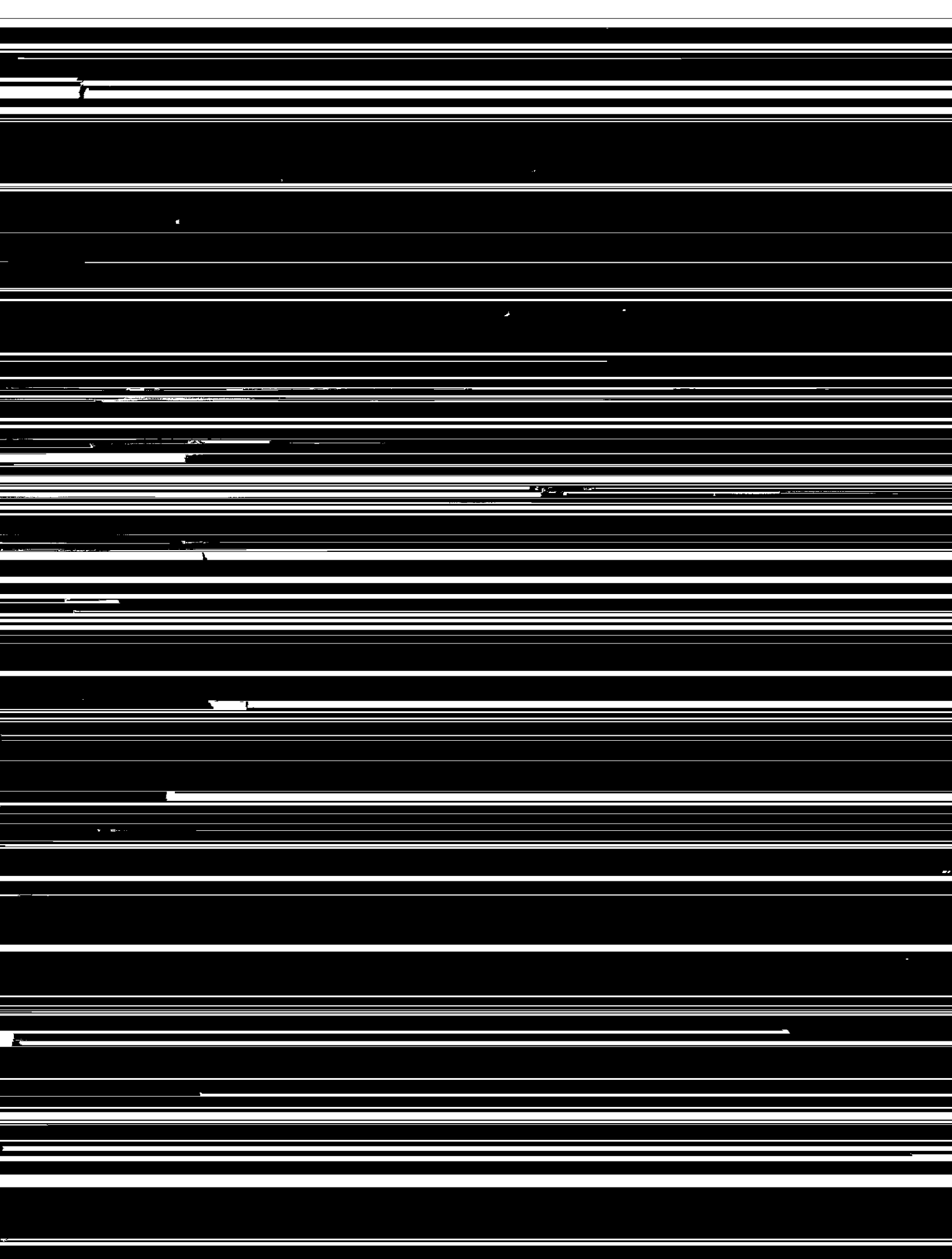


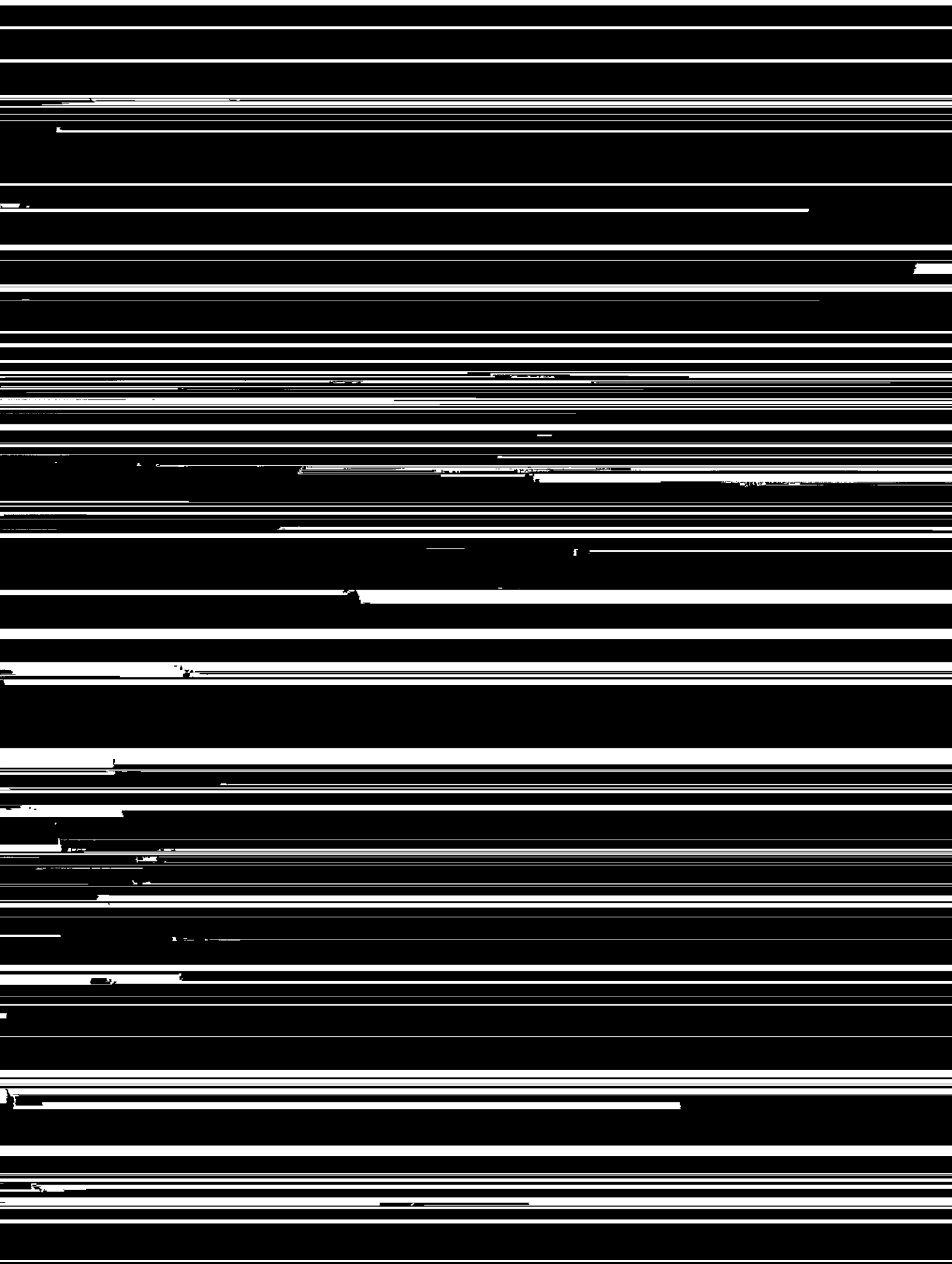








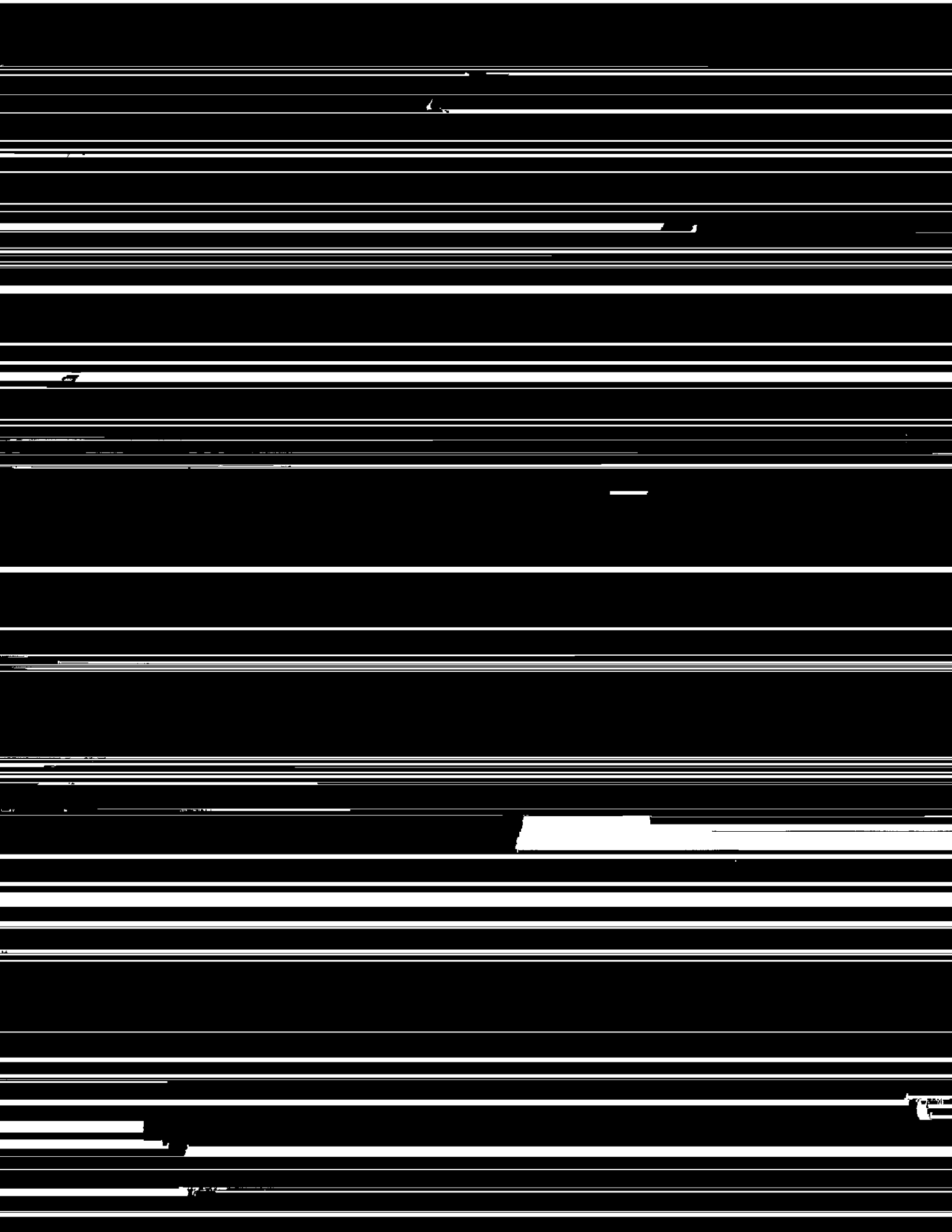


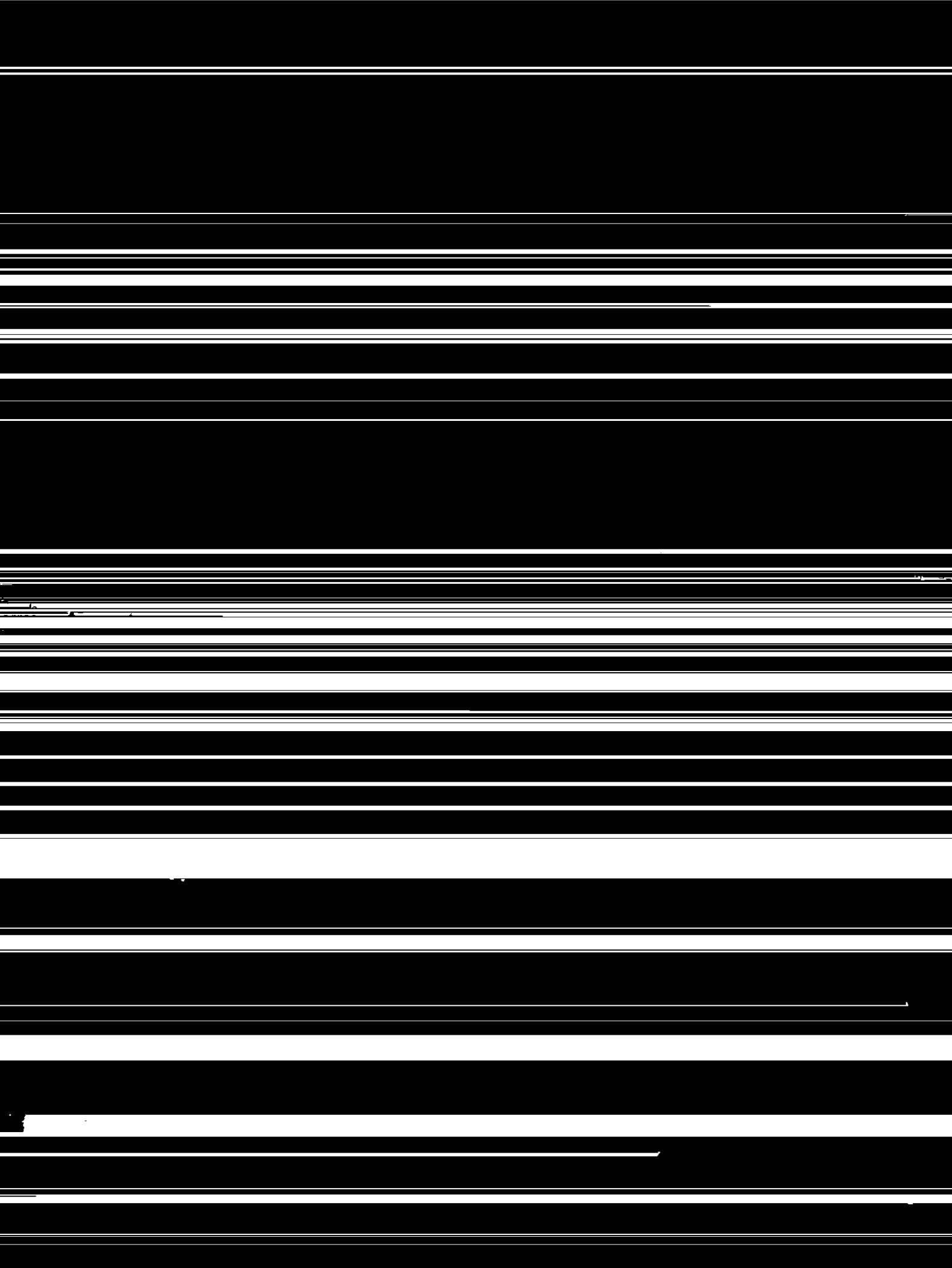


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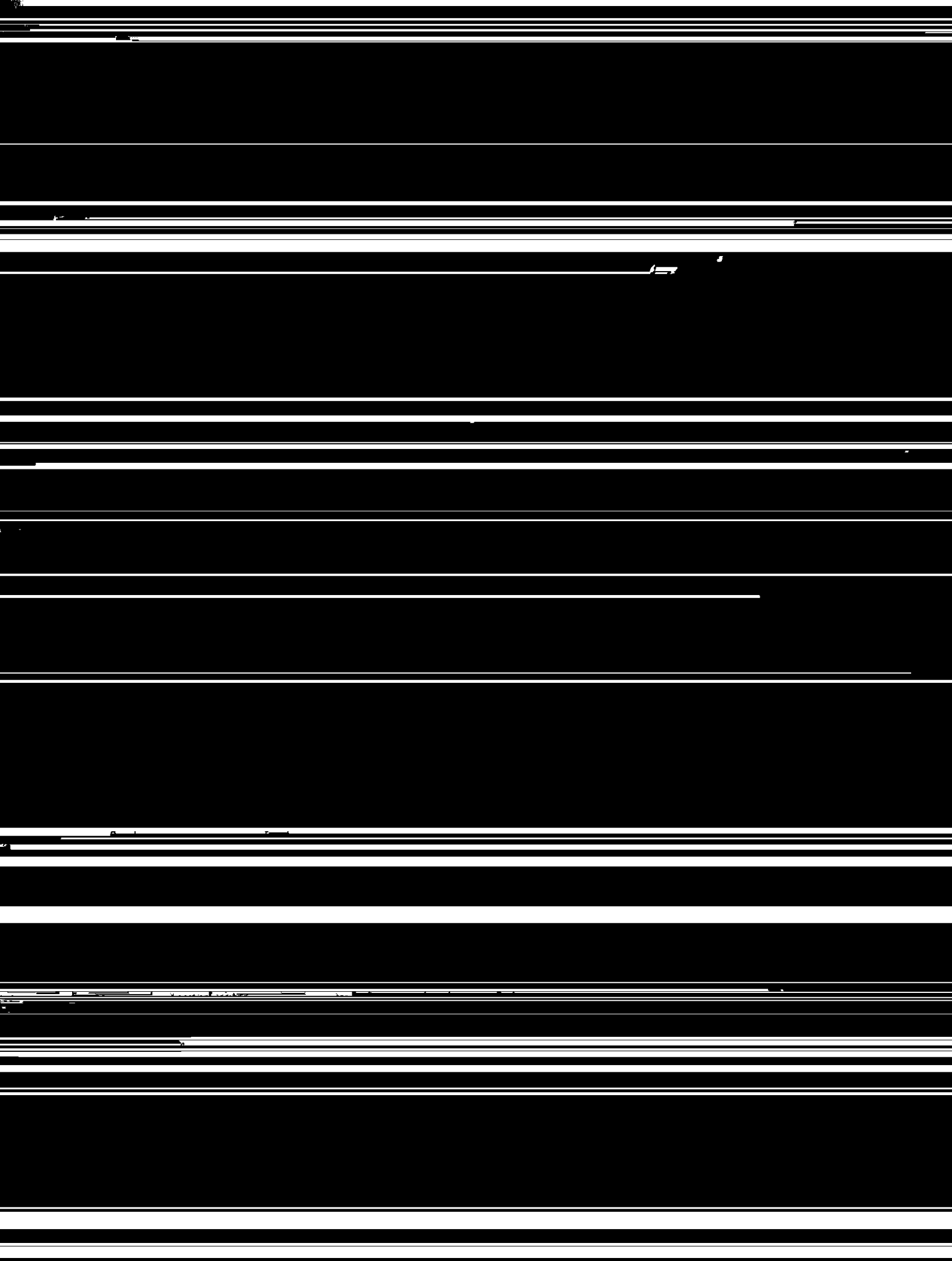
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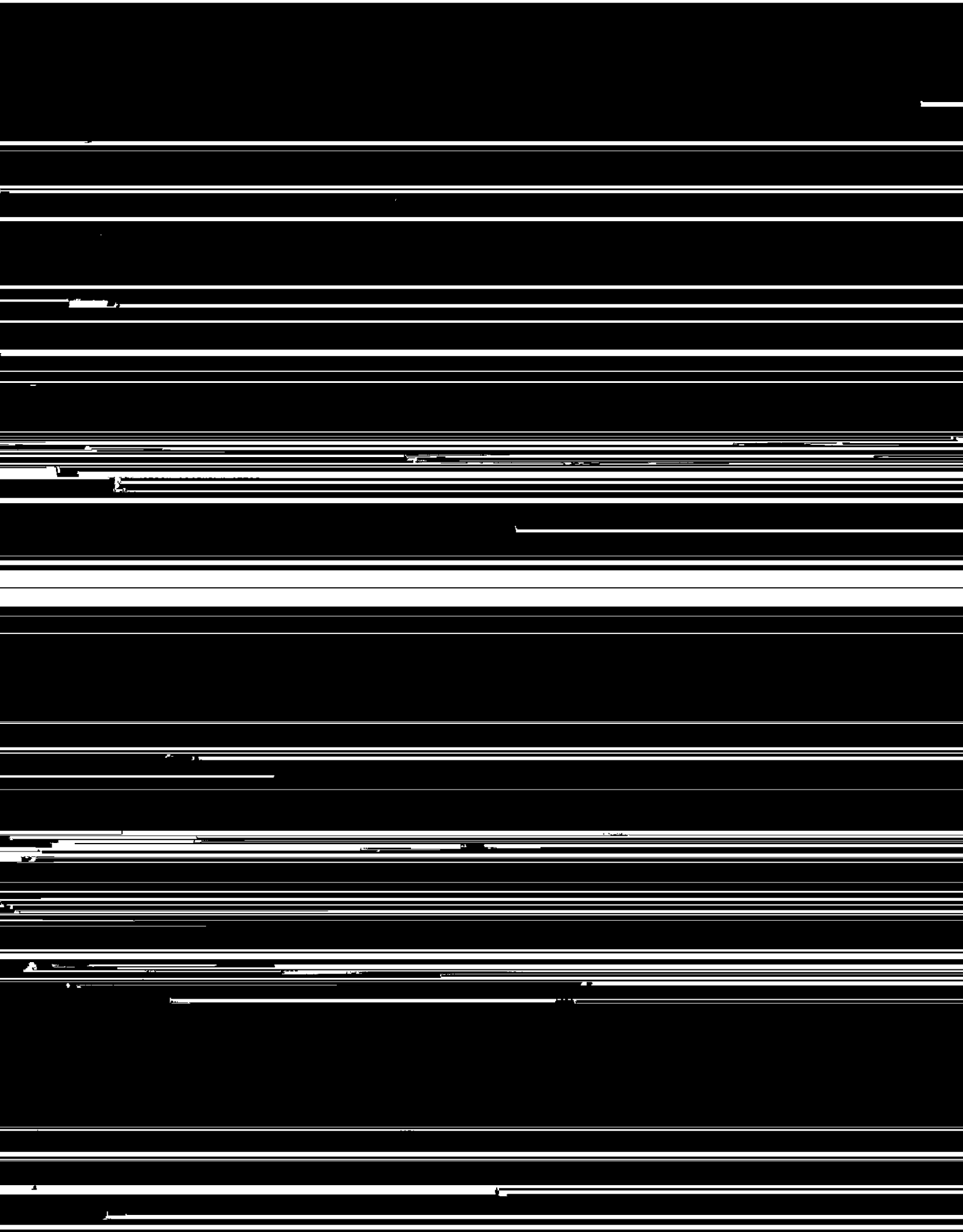
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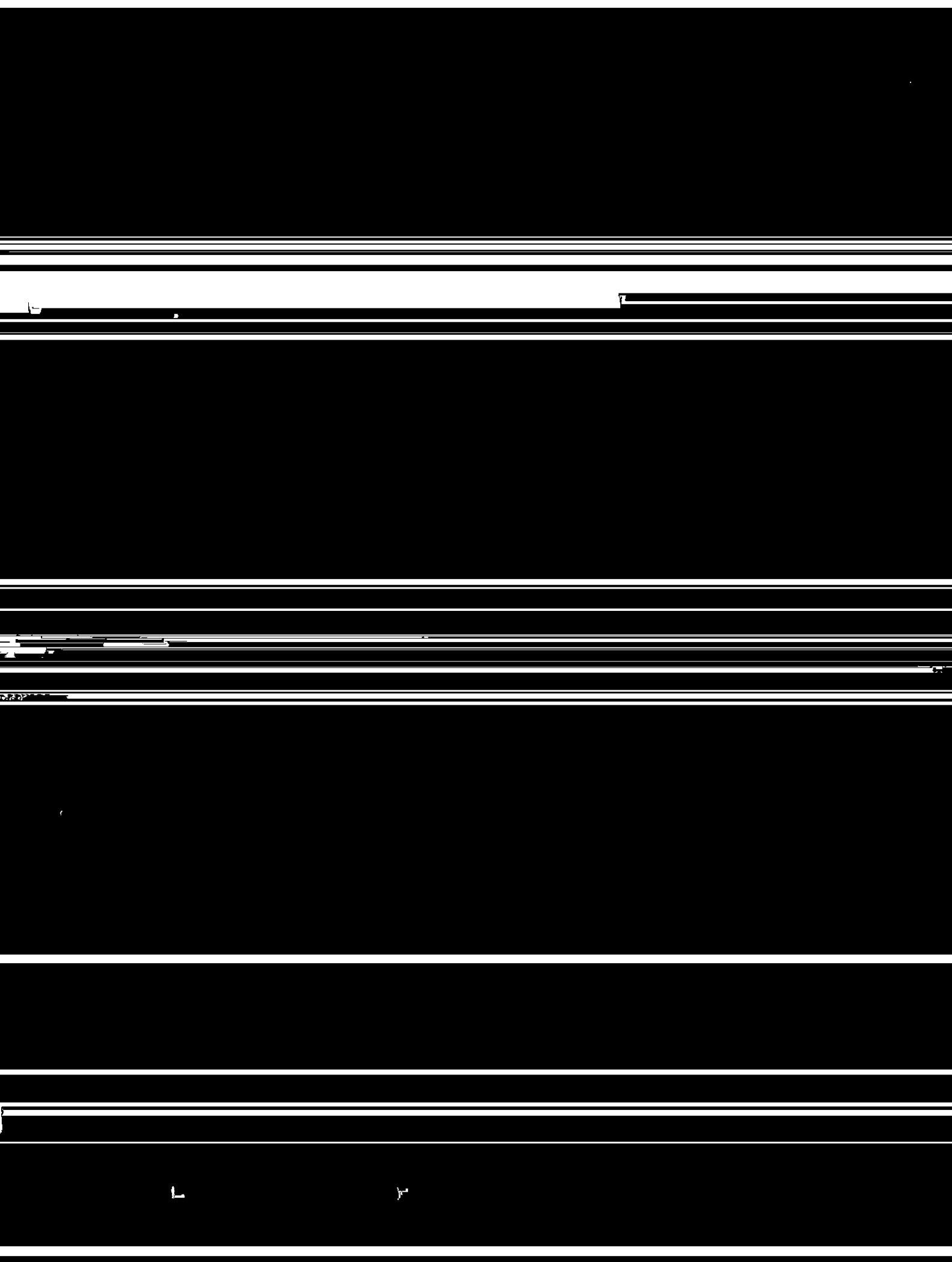
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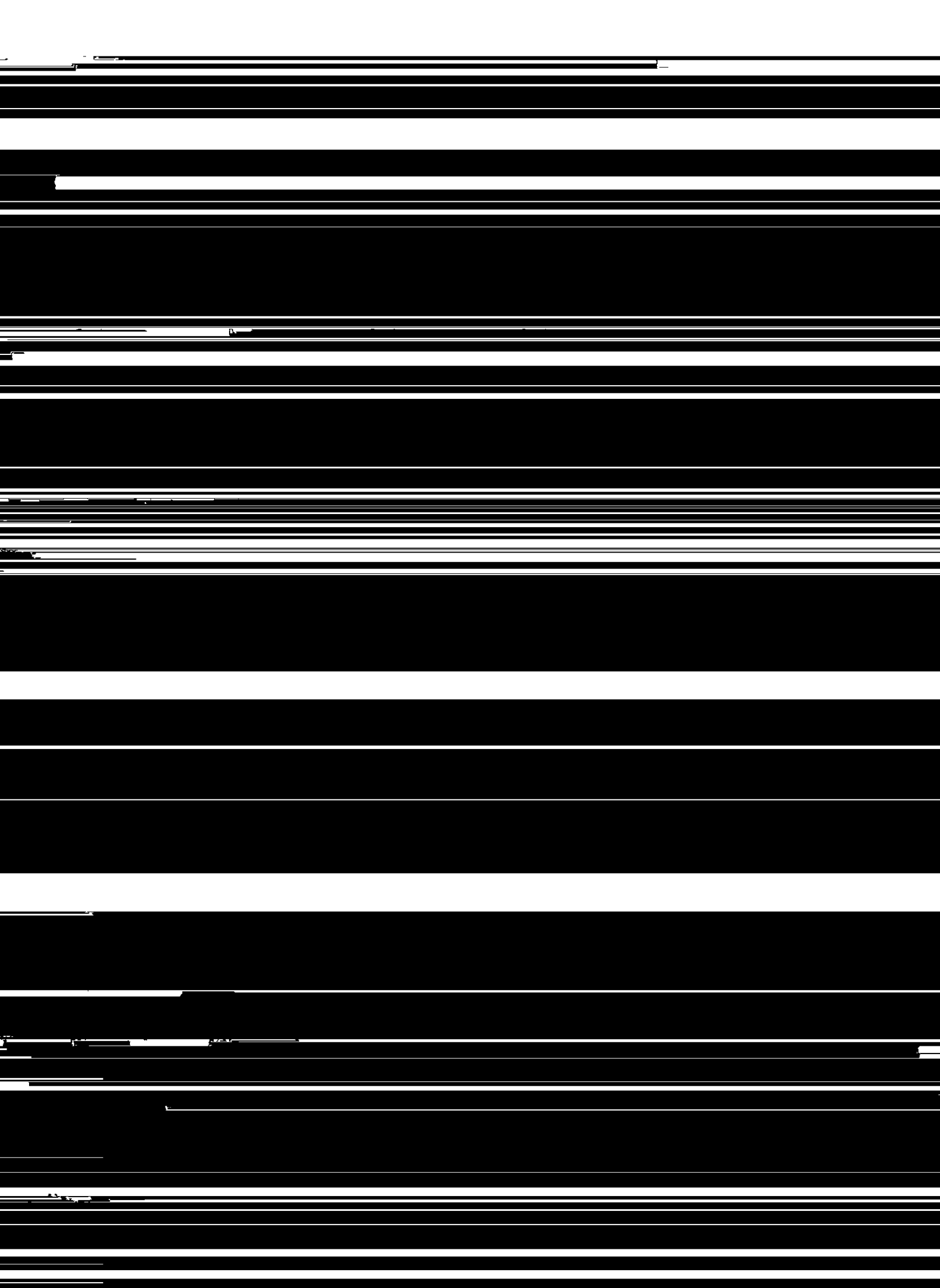
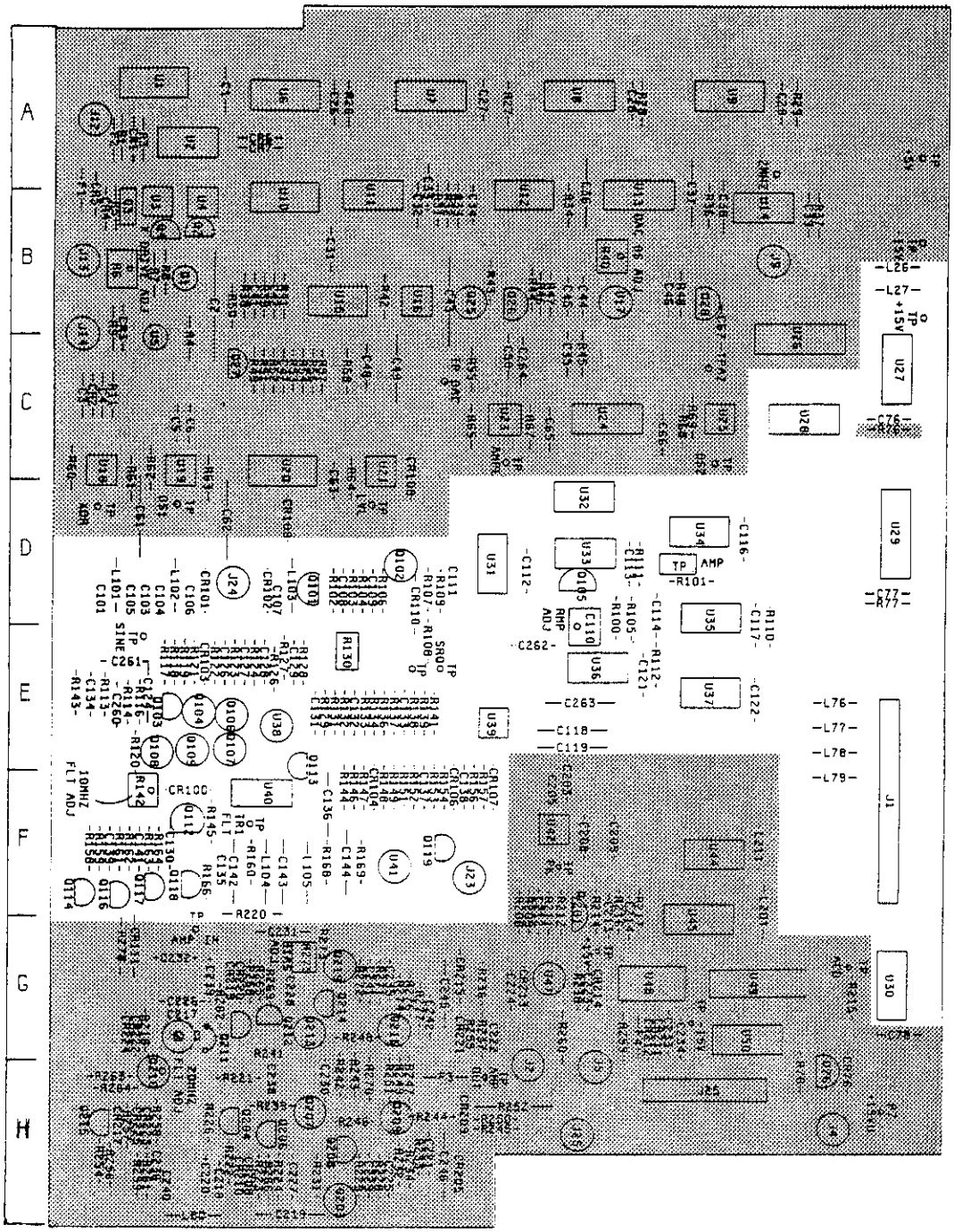
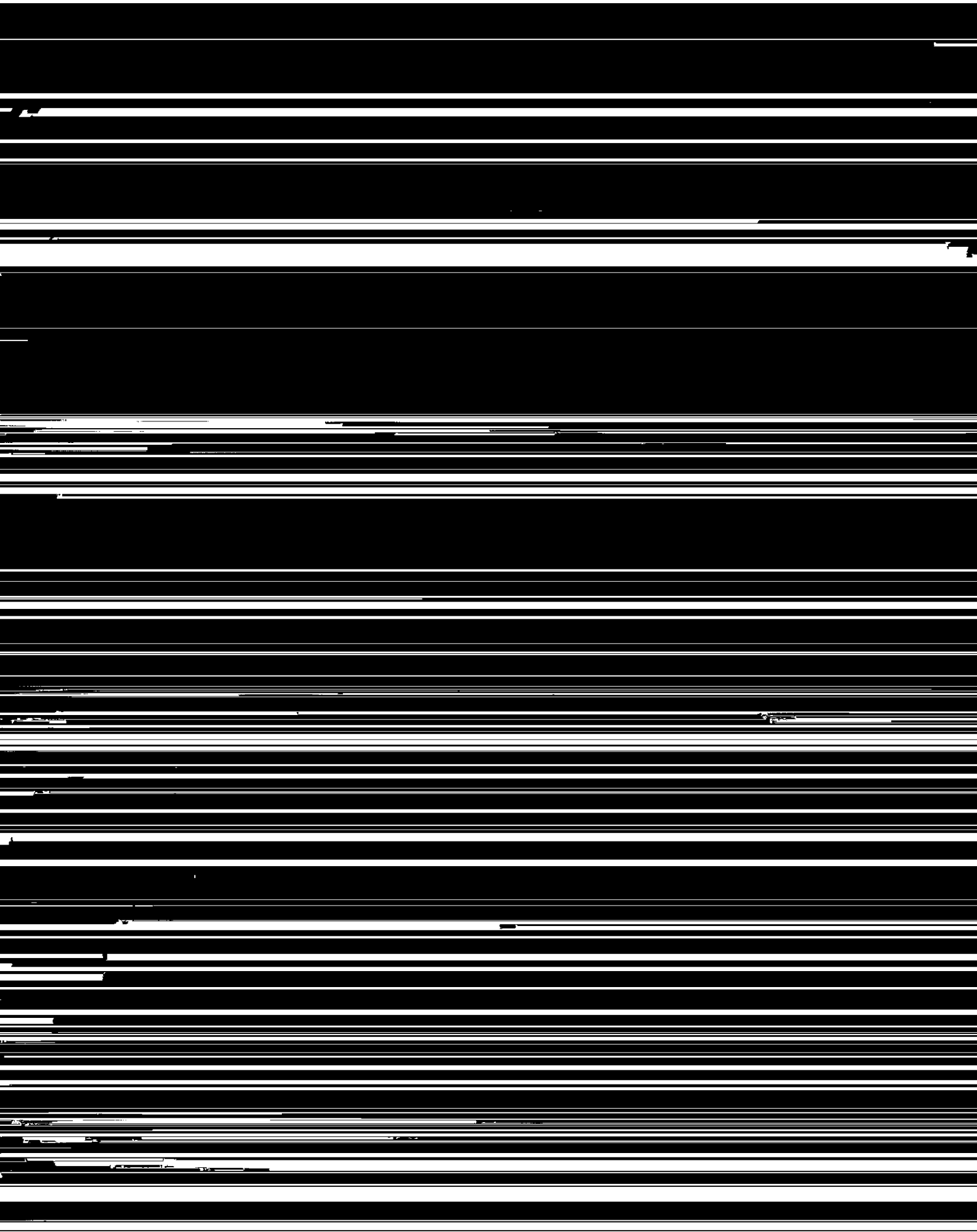


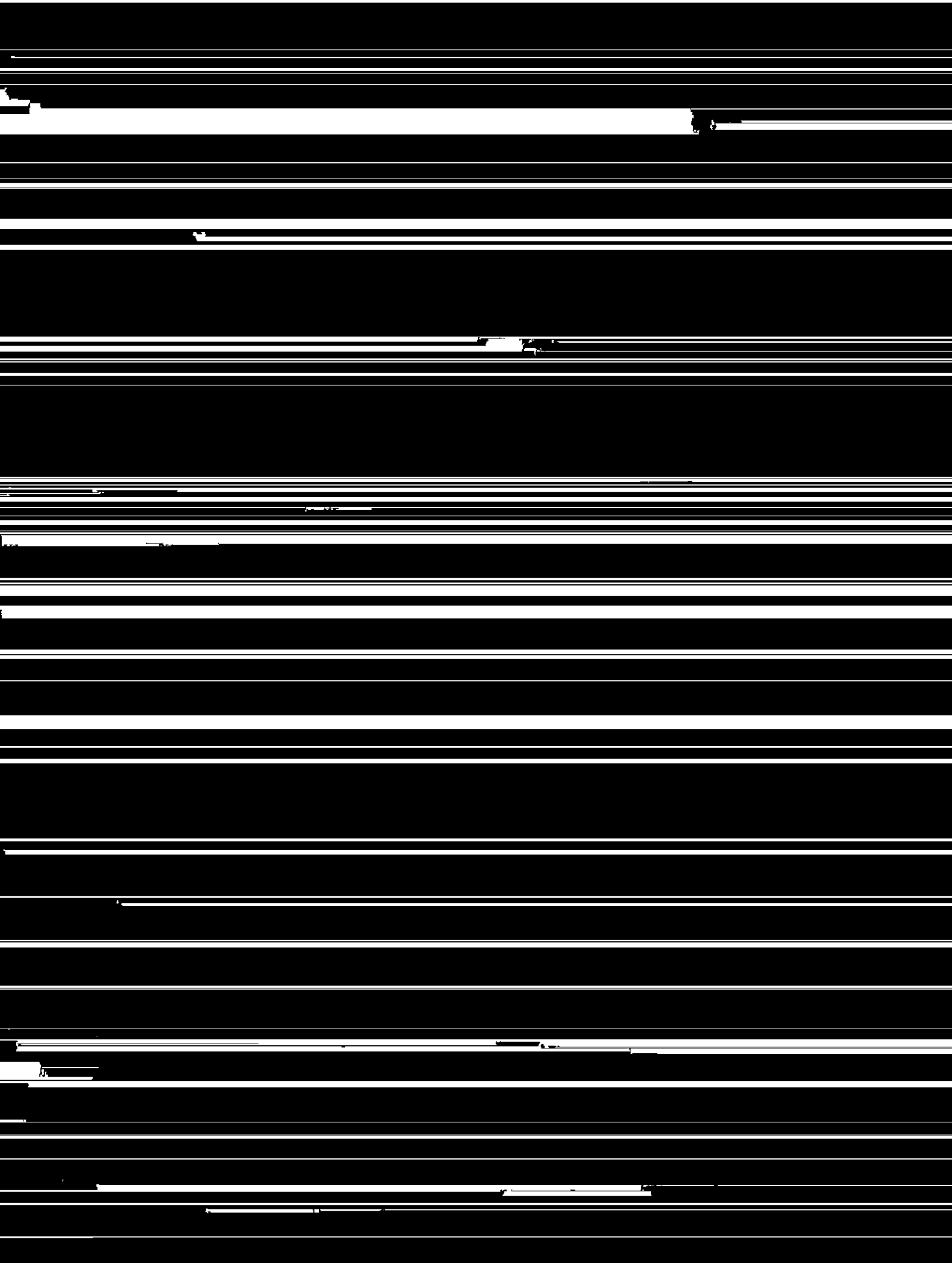
Fig 8-43
Sht 1 of 5



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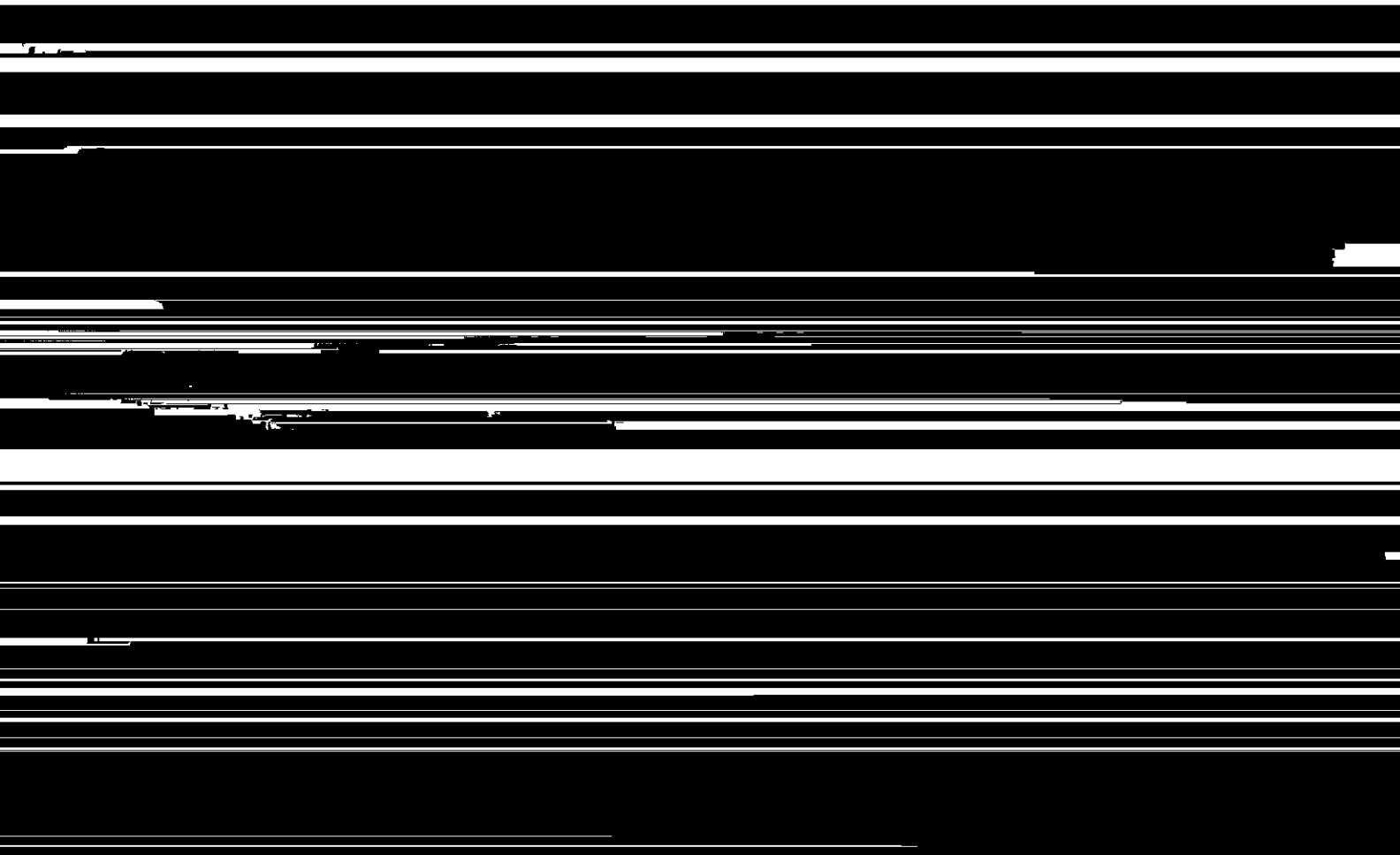


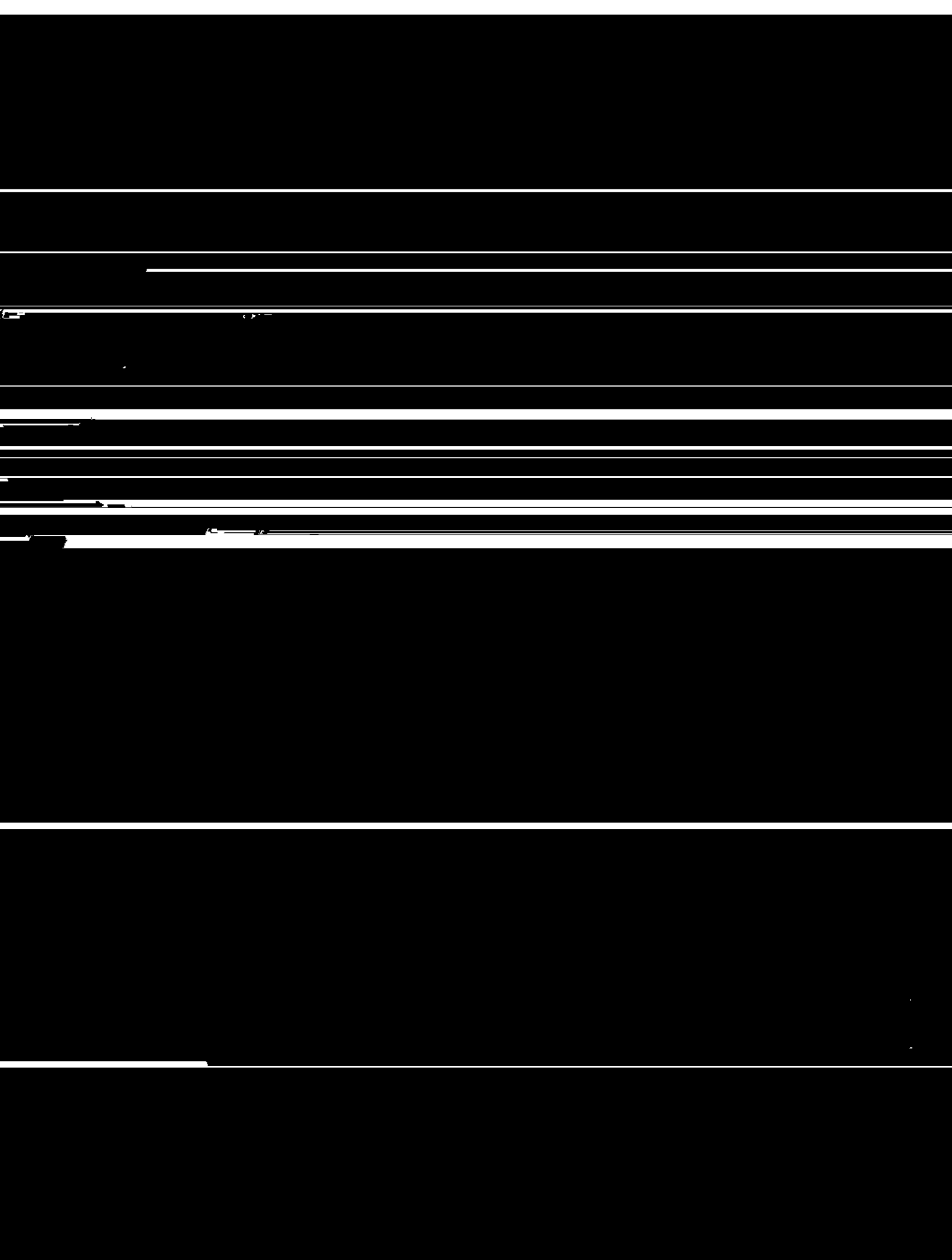


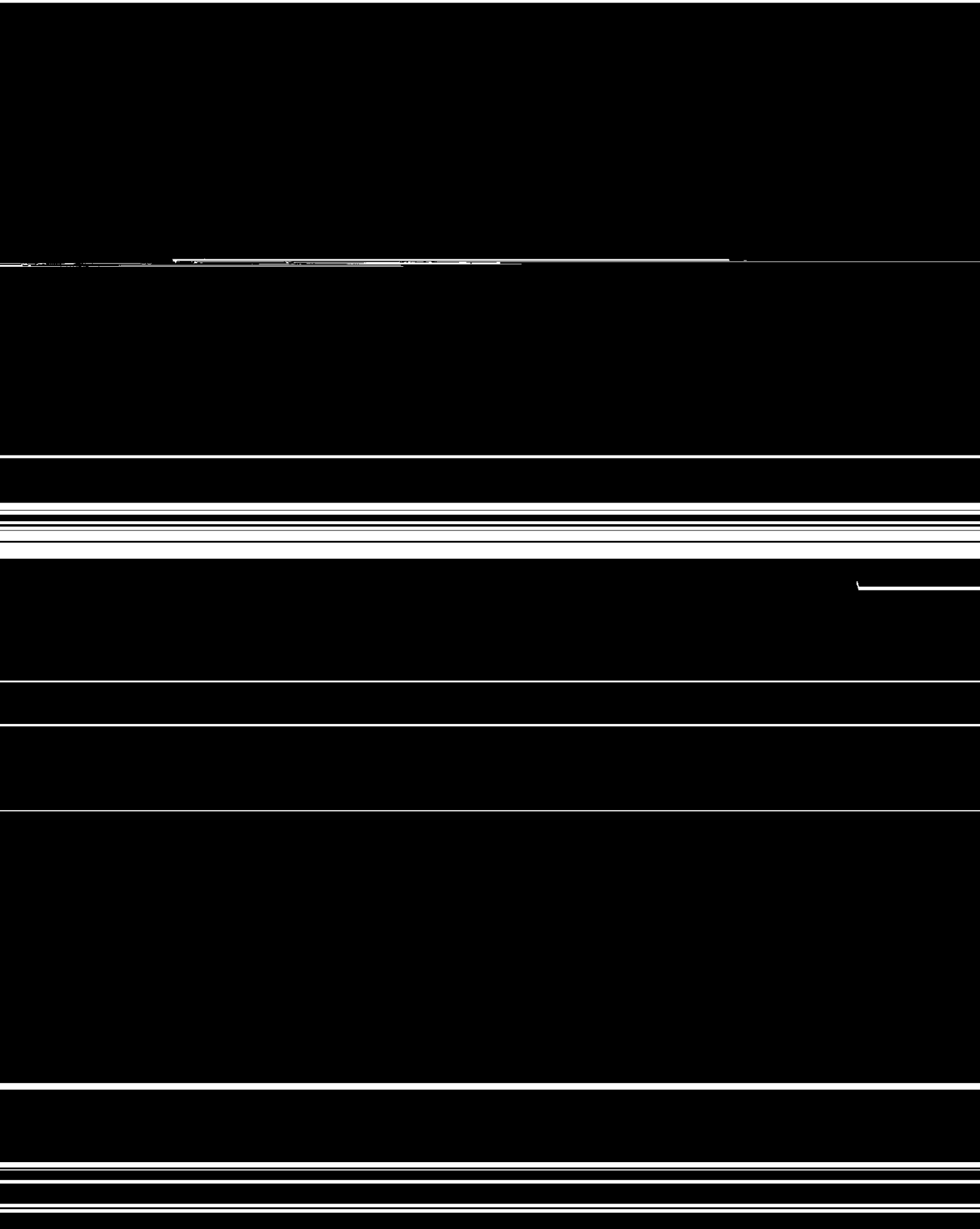


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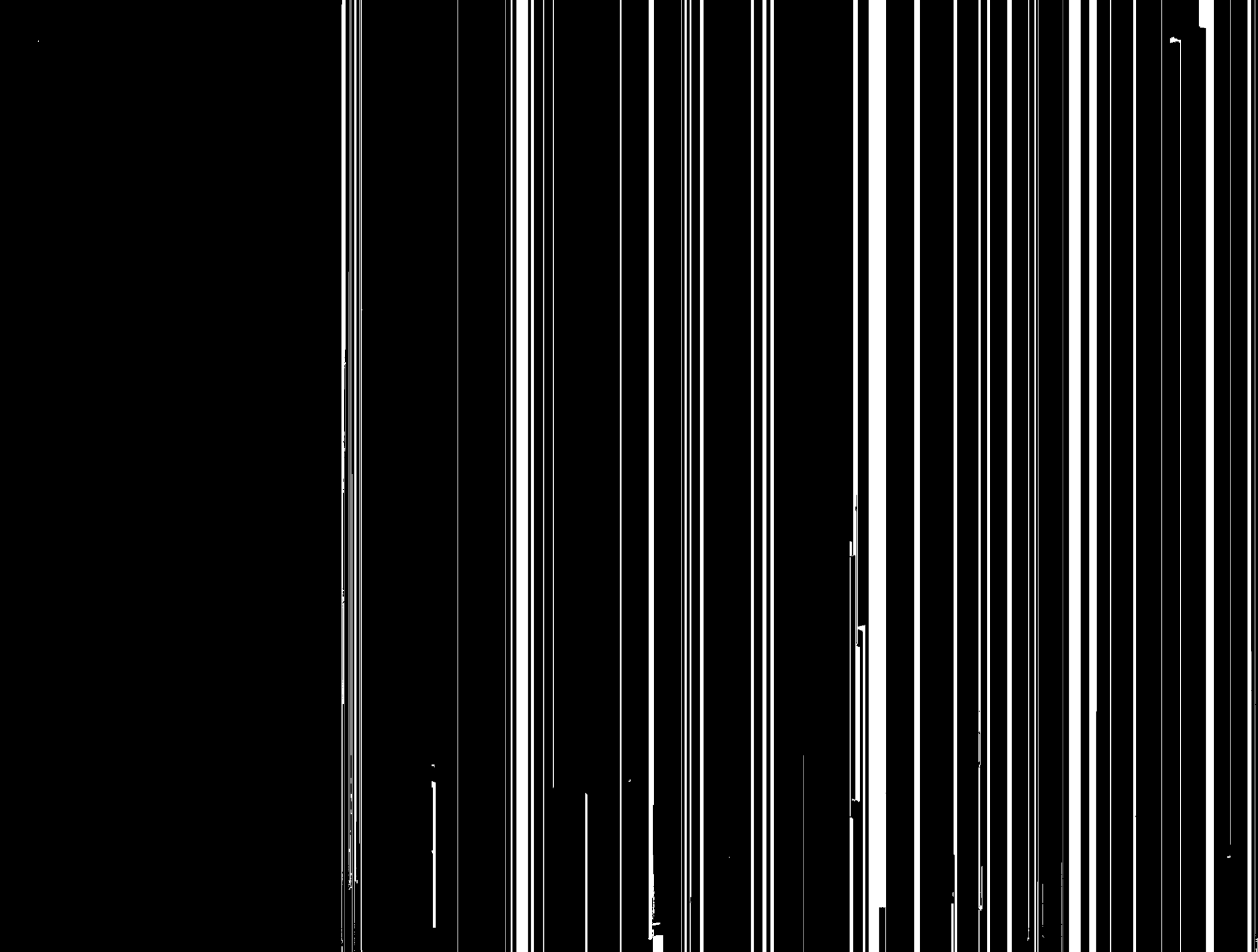
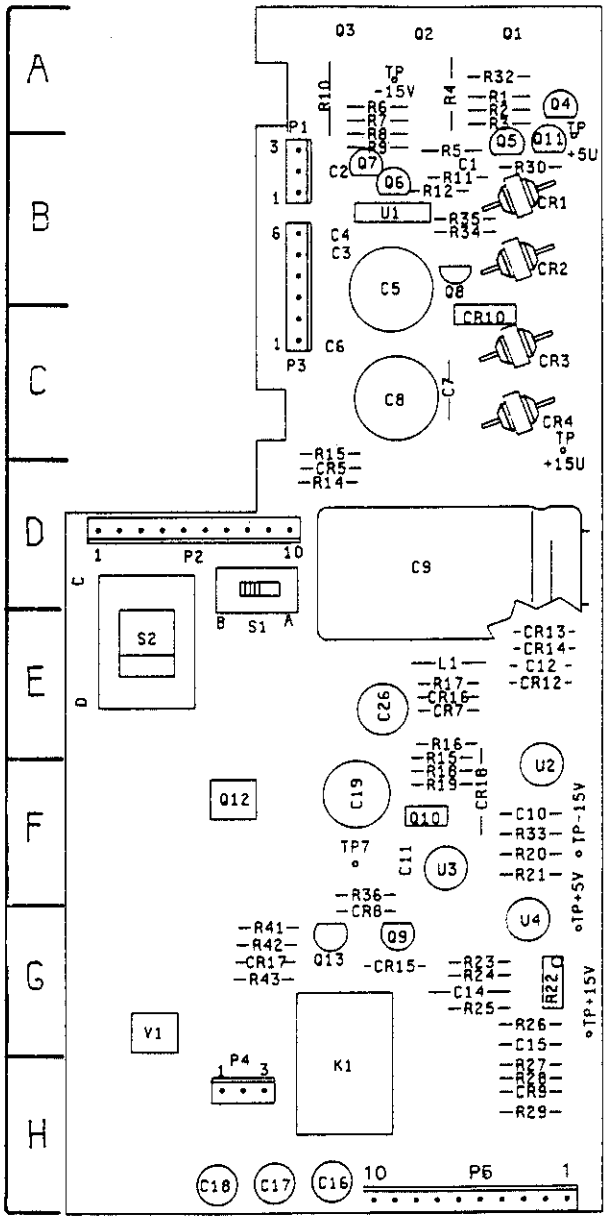


Fig 8-49
Sht 1 of 3



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