August 1966

Brief 66-10368

NASA TECH BRIEF

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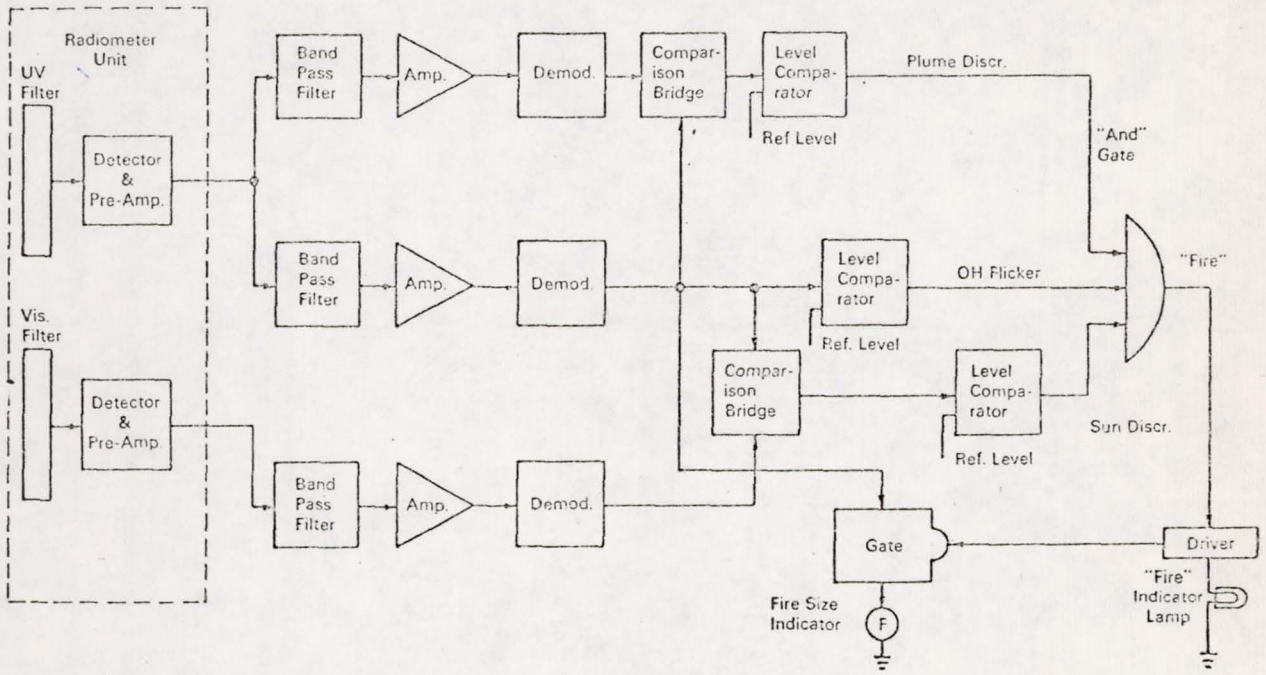
Hydrogen Fire Detection System Features Sharp Discrimination



The problem:

To design a system that will detect hydrogen fires quickly and with high reliability plus freedom from false alarms.

The solution:

A system that detects the flickering ultraviolet (UV) radiation emitted by the OH molecule, a short-lived intermediate combustion product found in hydrogen-air flames. In a space application, the system discriminates against false signals from sunlight and rocket engine exhaust plume radiation.

How it's done:

The system consists of a radiometer unit and signal processing circuitry. The radiometer unit contains quartz entrance optics, UV and visible filters, and UV and visible detectors with their preamplifiers. The signal processing circuitry is made up of three major logic subsystems: an OH flicker detector, a sun discriminator, and a rocket engine exhaust plume discriminator. The OH flicker detector circuit registers "true" only when viewing radiation flickering at appropriate frequencies, i.e., in the spectral region of OH UV emission from 2600 to 3200 angstroms.

(continued over)

Unmodulated sunlight is rejected by the OH flicker detector circuit. Rejection of the exhaust plume radiation is made by comparison of intensities in two temporal (frequency) regions at a single spectral point. The signal levels at the two frequencies are compared by a bridge and the plume discrimination circuit indicates a "false" signal for incident plume radiation.

Signals from the three signal processing circuits are applied to the "And" gate, which indicates "fire"only when all three subsystems give a "true" signal. A "fire" signal gates the fire size indicator whose output is proportional to the intensity of the modulated OH radiation.

Notes:

1. Although developed primarily for use in space hardware, this detection system could find use wherever hydrogen is manufactured, used, or stored.
2. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B66-10368

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: Clark S. Bright
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center

(M-FS-643)

F7200714

M-FS-643

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
INDUSTRIAL APPLICATIONS FLASH SHEET

IDENTIFYING SERIAL NO. (Assigned by Applications Officer)
M-FS-643

TO: NASA Headquarters, Code FF
Washington 25, D. C. (2 Copies)

FROM: (NASA installation)
George C Marshall Space Flight Center

This form is to be completed for each innovation used in NASA work. DEFINITION: for the purpose of this form, the term INNOVATION is defined as *"A means of accomplishing a work objective either more effectively than before, or for the first time."* The term includes the development, invention, discovery, modification or new use of a device, process, material, system, or technique.

1. INNOVATION CREDITED TO *(Individual(s), organization)*
Clark I. Bright, North American Aviation, Inc.

2. NAME OF INNOVATION
Detection of Hydrogen Fires by Ultraviolet OH Flicker Radiation

DATE FIRST USED

3. DESCRIPTION OF INNOVATION *(Include (a) present use, (b) functional details, (c) unusual features, (d) significant dimensions, (e) quantitative comparison to superseded means, (f) environmental factors that affect use, (g) cost, if significant.) (See Note A on reverse.)*

See attached disclosure 65R192

RECD FEB 25 1966

4. SUGGESTED APPLICATIONS *(Include those that would be feasible if the innovation were modified.) (See Note B on reverse.)*

Detection of hydrogen fires where system must discriminate against solar and infrared radiation.

PUBLICATION RELEASE ☐ YES ☐ NO

5. PATENT STATUS *(Local patent adviser to supply this information.)*

PATENTED		PATENT APPLIED FOR		PATENT CONTEMPLATED		PATENT ADVISER
NO.	DATE	NO.	DATE	☐ MAY BE FILED	☐ NOT TO BE FILED	DATE

FOR INNOVATIONS MADE BY A NASA CONTRACTOR OR SUBCONTRACTOR

6. CONTRACTOR ☒ PRIME ☐ SUB
North American Aviation, Inc.

CONTRACT NO. *(Include prime-contract number.)*
NAS8-11656

CONTRACTING OFFICER

NASA TECHNICAL REPRESENTATIVE

7. FLASH SHEET PREPARED BY	APPLICATIONS OFFICER	DATE
J.B. Bond	J.W. Wiggins	January 24, 1966

8. *Space for use of NASA HQS.*

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FOR INTRA-NASA USE ONLY

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NASA FORM 666 (REV. NOV. 62) PREVIOUS EDITIONS ARE OBSOLETE. *(Use additional sheets as necessary)*

M-FS-643

Invention Disclosure

DESCRIPTION OF INVENTION

Docket No. 65R192

[Describe(1) each new result obtained by the invention, (2) basic components, ingredients, or steps which are combined to obtain such results, and (3) the operation of the components, etc., which obtain such results. Provide sketches or flow diagrams if helpful in understanding the invention.]

A breadboard fire detection system for the upper stages of the Saturn vehicle was developed under contract number NAS8-11656 with NASA, MSFC. The goal of the fire detection system is to detect hydrogen fires in the missile rapidly and with high reliability and freedom from false alarms. The basis of the system's operation is the detection of the flickering ultraviolet (UV) radiation emitted by the OH molecule, a short-lived intermediate combustion product found in hydrogen-air flames. The principal technical innovations are the methods of discrimination against false signals from sunlight and the J-2 rocket engine exhaust plume radiation.

The primary use of the fire detection system would be in detecting hydrogen fuel fires in missiles and around rocket engine static test stands. The system could also be adapted to detecting hydrogen fires in locations where hydrogen is manufactured, used, or stored. Direct applications to other fire detection problems could be made as long as the fires to be detected emit strong OH radiation, as, for example, hydrocarbon-air fires. In general, the principles used in the system can be applied to most fire detection needs, provided the appropriate spectral and frequency characteristics of the fires are known.

There have been a number of fire detectors developed which detect the radiation emitted by fires (see, for example, Refs. 1-6). Most of these systems detect the infrared emission, and some only the time varying components of the infrared radiation. However, at least two companies, Minneapolis-Honeywell and McGraw-Edison, manufacture UV-sensitive fire detection systems. None of these systems employs reliable methods of discrimination against J-2 engine exhaust radiation or time-varying solar radiation, whether at the earth's surface or outside the atmosphere.

The fire detection system is composed of a radiometer unit and a signal processing unit (see diagram). The radiometer unit contains quartz entrance optics, UV and visible filters, and UV and visible detectors with their preamplifiers. The signal processing unit contains three major logic subsystems: (1) the OH flicker detector, (2) the sun discriminator, and (3) the rocket engine exhaust plume discriminator.

The OH flicker detector subsystem registers "true" only when viewing radiation flickering at appropriate frequencies in the spectral region of OH UV emission (2600-3200 Å). Unmodulated sunlight is rejected by the OH flicker detector subsystem.

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(1)

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NORTH AMERICAN AVIATION, INC.

Invention Disclosure

DESCRIPTION OF INVENTION

Docket No. [illegible]

[Describe(1) each new result obtained by the invention, (2) basic components, ingredients, or steps which are combined to obtain such results, and (3) the operation of the components, etc., which obtain such results. Provide sketches or flow diagrams if helpful in understanding the invention.]

The technique of discrimination against time-varying solar radiation, e.g. modulated by atmospheric turbulence or by reflection from a vibrating missile part, is the "two-color" method. This method is basically the comparison of intensities in two spectral regions, in this case one in the UV and the other in the visible region. The ratios of these intensities are different for hydrogen flame radiation and sunlight. In the system, the outputs of appropriately filtered UV and visible detectors are compared by means of a bridge network. The detection of modulated sunlight results in a "false" signal indication from the sun discriminator, whereas hydrogen fire radiation results in a "true" signal indication. Note that, because of the bridge comparison technique, a small hydrogen fire will cause a "fire" indication even in the presence of modulated sunlight.

Discrimination against the J-2 exhaust radiation is accomplished by a two-frequency technique analogous to the two-color technique. The two-color technique cannot be applied to plume discrimination because the spectral radiation characteristics of the plume and of hydrogen fires are quite similar. The two-frequency method is the comparison of intensities in two temporal (frequency) regions at a single spectral region. The flicker frequency characteristics of the J-2 plume and hydrogen flames were found to be dissimilar, so that the two sources can be reliably distinguished by this method. In the plume discrimination subsystem, the signal from the UV detector is amplified and separately filtered at the two frequencies. The signal levels at the two frequencies are compared by a bridge. When the appropriate frequencies (pass bands) and bridge ratio are set, the plume discrimination subsystems indicates a "false" signal for incident plume radiation and a "true" signal for incident flame radiation. Again, the bridge technique allows detection of a fire in the presence of engine exhaust plume radiation.

The signals from the three subsystems are applied to the "And" gate. The output from the "And" gate will indicate "fire" only when all three subsystems give a "true" signal. The "fire" signal gates the fire size indicator; the fire size output is proportional to the intensity of the modulated OH radiation.

The fire detection system is undergoing further development. Therefore, its final form may be somewhat different from that described here.

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Invention Disclosure

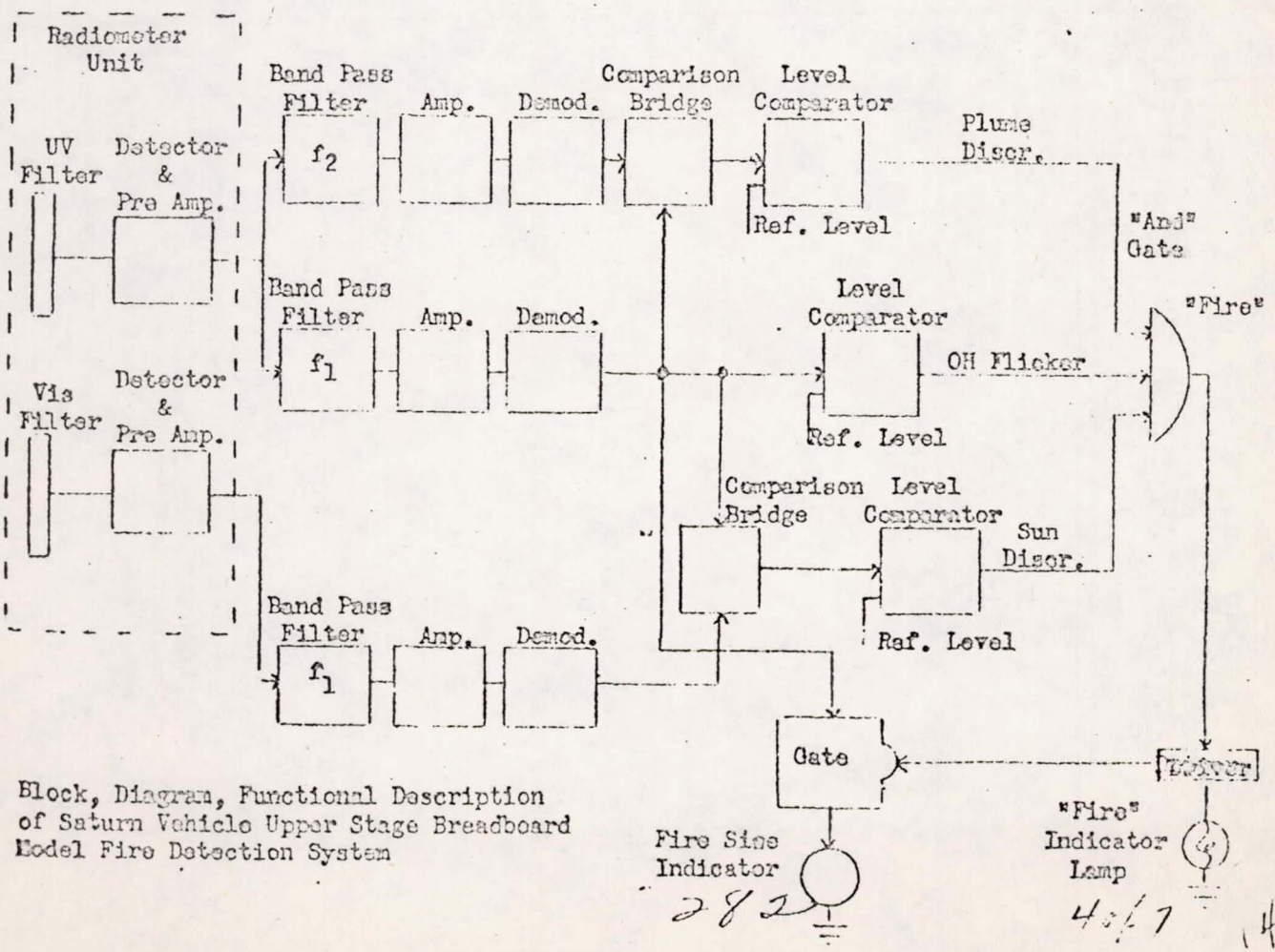
DESCRIPTION OF INVENTION

Docket No. 65272

[Describe(1) each new result obtained by the invention, (2) basic components, ingredients, or steps which are combined to obtain such results, and (3) the operation of the components, etc., which obtain such results. Provide sketches or flow diagrams if helpful in understanding the invention.]

REFERENCES

1. "Development of High Speed Detector, Final Report", Factory Mutual Research Corp., 1 December 1964, DDC AD 456 290.
2. "Fire Detection System for the Saturn Vehicle, Study Phase Final Report", Honeywell, Report No. R-ED4163, April 1963, CONFIDENTIAL.
3. "Application and Design Data, Fireye Aircraft Fire Detection Systems", Electronics Corp. of America, Tech. Bull. 8-10-54, DDC AD 39 454.
4. "General Data, Pyrotector Aircraft Fire Detection System", Pyrotector Corp.
5. "Research on an Ultraviolet Flame Detector System", Potcar Research Corp., February 1952, DDC. AD 12 275.
6. "Study of Explosion and Fire Suppression of Aircraft Engine Sections", WADC Tech. Rept. 57-300, April 1957, DDC AD 130 957.



Block, Diagram, Functional Description of Saturn Vehicle Upper Stage Breadboard Model Fire Detection System

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GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

Memorandum

TO Leon D. Wofford, Jr., CC-P DATE January 24, 1966

FROM Technology Utilization Office, MS-T

SUBJECT Marshall Flash Sheet Number M-FS- 643

It is requested that the patent status of the above identified innovation be supplied on the attached information sheet.

James B Bond
New Technology Representative

MSFC - Form 488 (August 1960)

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TECHNOLOGY UTILIZATION OFFICE
MARSHALL SPACE FLIGHT CENTER
Huntsville, Alabama

INNOVATION: DETECTION OF HYDROGEN FIRES BY ULTRAVIOLET OH FLICKER RADIATION

SOURCE: New Technology Report, Contract NAS8-11656

PATENT STATUS

(Indicate by filling in or checking the applicable blanks)

NASA Case No. 5857 MSFC Branch No. 1325 E

I. PATENT ISSUED: No X Yes____

A. Patent Number _____

B. Government Title_____

C. Government License_____

D. No Government Rights_____

II. PATENT APPLIED FOR: No X Yes____

A. Employee Inventions

1. Government Title_____

2. Government License_____

3. No Government Rights_____

4. Government Rights Unknown_____

B. Contractor Inventions

1. Government Title_____

2. Government License (Title Waiver Granted)_____

3. Title Waiver Pending_____

4. Government Rights Unknown_____

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III. PATENT NOT APPLIED FOR

A. Patentability

1. Very Good Possibility _____
2. Maybe X
3. None _____
4. Unknown _____

B. Government Intention

1. To file a patent application _____
2. Not to file a patent application _____
3. Indefinite at this time X

C. Employee Inventions

1. Government Title _____
2. Government License _____
3. No Government Rights _____
4. Government Rights undecided _____
5. Employee interested in filing a patent application _____

D. Contractor Inventions

1. Government Title X
2. Government License (Title Waiver Granted) _____
3. Title Waiver Pending _____
4. Government Rights unknown _____

Patent Representative

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