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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: September 9, 1977

Project Title: Equipment for Instrumentation and Experimentation in Heart-Muscle Mechanics

Project No: E-23-631

Project Director: Dr. Hyland Y.-L. Chen

Sponsor: National Science Foundation

Agreement Period: From 9/1/77 Until 2/28/79
(12-month budget period plus 6-month flexibility period)

Type Agreement: Grant No. ENG77-17233

Amount: \$19,300 NSF
19,248 GIT (E-23-330)
\$38,548

Reports Required: Final Technical Report; Summary of Completed Project

Sponsor Contact Person (s):

Technical Matters

Division of Engineering
National Science Foundation
Washington, D. C. 20550

Contractual Matters

(thru OCA)

Ms. Mary Frances O'Connell
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Division of Grants and Contracts
National Science Foundation
Washington, D. C. 20550
(202) 632-2858

Defense Priority Rating: N/A

Assigned to: Engineering Science and Mechanics (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
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Project File (OCA)
Project Code (GTRI)
Other _____

10

Date: 1/29/81

Project No: E-23-631

Sponsor: NSF

Clearance of Accounting Charges: ---

- ☐ Final Invoice and Closing Documents
- ☒ Final Fiscal ~~Report~~ FCTR (Accounting)
- ☒ Final Report of Inventions (if positive)
- ☐ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____

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Project Code (OCA)

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I-PROJECT IDENTIFICATION INFORMATION

1. Institution and Address Georgia Institute of Technology Atlanta, Georgia 30332	2. NSF Program Engineering	3. NSF Award Number ENG77-17233
	4. Award Period From 9/1/77 To 2/28/79	5. Cumulative Award Amount \$19,300

6. Project Title

"Equipment for Instrumentation and Experimentation in Heart-Muscle Mechanics".

PART II-SUMMARY OF COMPLETED PROJECT (FOR PUBLIC USE)

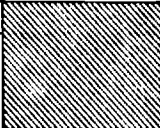
An experimental system for the studies of the mechanical and optical properties of heart muscle is designed and constructed.

The system consists of four major subsystems, i.e., environmental, mechanical, optical and control systems. The environmental system provides control of the pH, pO_2 , temperature and programmed electric stimulation of the specimen. To cope with the rapidly and continuously changing active state of heart muscle, a fast close-looped, electro-mechanical system is designed with a steady state rise time of 100 microseconds. (Comparable to the huxley's of 400 microseconds).

The optic system consists of a laser and accessories which measures muscle length without artifact introduced by damages ends, and birefringence due to muscular activity. The control system consists of a minicomputer and accessory I/O devices used to monitor and control the movement of the mechanical system, pH, temperature and stimulation; it also monitors pO_2 , displacement and force data via special purpose digital processing units.

As a by-product, an optic probe for the viability of myocardium is invented.

PART III-TECHNICAL INFORMATION (FOR PROGRAM MANAGEMENT USES)

1. ITEM (Check appropriate blocks)	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (✓)	Approx. Date
a. Abstracts of Theses	X				
b. Publication Citations	X				
c. Data on Scientific Collaborators	X				
d. Information on Inventions		X			
e. Technical Description of Project and Results					Jan. 1981
f. Other (specify)					
2. Principal Investigator/Project Director Name (Typed) Hyland Y. L. Chen	3. Principal Investigator/Project Director Signature			4. Date 12-12-81	

This is an important legal document. Read instructions carefully before filling in data.

PROJECT NO. _____		RECOMMENDED SECURITY CLASSIFICATION _____		REC. OF INV. NO. <u>661CS</u>	
CONTRACT NO. _____					
1. NAME OF INVENTOR <u>Hyland Y. L. Chen</u>			POSITION <u>Assistant Professor</u>		
2. DEPARTMENT OR DIVISION <u>ESM Department, Georgia Institute of Technology</u>					
3. DATES OF EMPLOYMENT <u>1973-date</u>					
4. PRESENT ADDRESS (No. Street, City, County, State) <u>20-G Plumtree Drive, Smyrna</u>			TELEPHONE <u>952-6909</u>		PERMANENT OR UNTIL
5. PERMANENT ADDRESS (No. Street, City, County, State) <u>ESM, Ga. - Tech, Atlanta, Georgia 30332</u>			TELEPHONE <u>894-2790</u>		
6. NAMES (S) AND ADDRESS (ES) OF CO-INVENTORS (If any) <u>N/A</u>					
7. DESCRIPTIVE TITLE OF INVENTION <u>An Optic Probe for the viability of Myocardium</u>					
8. LIST DRAWINGS, SKETCHES, PHOTOS, REPORTS, DESCRIPTIONS, NOTEBOOK ENTRIES, ETC. WHICH SHOW OR DESCRIBE INVENTION <u>A schematic is attached for this report</u>					
9. EARLIEST DATA AND PLACE INVENTION WAS CONCEIVED (Brief outline of circumstances) <u>Ga. Tech, Sept., 1975. During the design of an optical system to avoid the "damaged end" artifact in heart muscle research I saw that laser light had been used in the sense of illumination by Hefner and of Fourier waves by Pollack. Continuing this line of thought, I saw that by using laser light as an electromagnetic wave, a device</u>					
10. DATE AND PLACE OF FIRST SKETCH, DRAWING OR PHOTO <u>n/a</u> to test the viability of myocardium in situ could be developed					
11. DATE AND PLACE OF FIRST WRITTEN DESCRIPTION <u>n/a</u>					
12. DISCLOSURE OF INVENTION TO OTHERS					
NAME, TITLE AND ADDRESS		FORM OF DISCLOSURE	DATE AND PLACE OF DISCLOSURE		WAS SIGNATURE OBTAINED (YES OR NO)
<u>Dr. Y. C. Fung, Professor, AMES-Bioengineering</u>		<u>discussion</u>	<u>around Dec., 1975</u>		<u>no</u>
<u>UGSD LaJolla, Calif. 92093</u>					
<u>Dr. Allen Brady, Professor, Dept. of</u>		<u>discussion</u>	<u>around Dec., 1976</u>		<u>no</u>
<u>Physiology, UCLA. LA, Calif.</u>		<u>(List to be continued)</u>			
12.A IMPORTANT - HAVE ANY PUBLICATIONS OR REPORTS BEEN MADE ON THIS INVENTION? <u>no.</u>					
13. DATE AND PLACE OF COMPLETION OF FIRST OPERATING MODEL OR FULL SIZE DEVICE <u>N/A</u>					
14. PRESENT LOCATION OF MODEL <u>N/A</u>					
15. DATE, PLACE, DESCRIPTION AND RESULTS OF FIRST TEST OR OPERATION <u>NONE</u>					

12.

DISCLOSURE OF INVENTION TO OTHERS

NAME, TITLE AND ADDRESS	FORM OF DISCLOSURE	DATE AND PLACE OF DISCLOSURE	WAS SIGNATURE OBTAINED (YES OR NO)
Dr. Robert Schlant, Head, Dept. of Cardiology Emory University, Atlanta, Georgia	discussion	early 1977	no
Dr. L. L. Hefner, Professor, Dept. of Cardiology UAB, Birmingham, Alabama	discussion	mid 1977	no
Dr. Steve Yandle, Naval Medical Research Cntr Bethesda, MD	discussion	Feb. 1979	no
Dr. Newman Stevens, Professor, Univ. of Winnipeg, Canada	discussion	around 1978	no

12.

DISCLOSURE OF INVENTION TO OTHERS

NAME, TITLE AND ADDRESS	FORM OF DISCLOSURE	DATE AND PLACE OF DISCLOSURE	WAS SIGNATURE OBTAINED (YES OR NO)
Dr. John Lundberg, Professor, Textile Engineering Georgia Tech	discussion	around early 1976	no
Dr. B. Zimm, Professor of Chemistry UCSD La Jolla, California 92093	discussion	January, 1977	no
Dr. T. Donalds, Cardiology UAB Birmingham, Alabama	discussion	around 1977	no
Dr. C. Astill, NSF	discussion	around 1977	no

16. NAMES AND ADDRESSES OF WITNESSES OF FIRST TEST

NONE

17. DATE, PLACE, DESCRIPTION AND RESULTS OF LATER TESTS (name witnesses)

NONE

18. IDENTIFY RECORDS OF TESTS AND GIVE PRESENT LOCATION OF RECORDS

NONE

19. PRIOR REPORTS OR RECORDS OF INVENTION TO WHICH INVENTION IS RELATED

NONE

20. OTHER KNOWN CLOSELY RELATED PATENTS, PATENT APPLICATIONS AND PUBLICATIONS

PATENT OR APPLICATION NO.	DATE	TITLE OF INVENTION OR PUBLISHED ARTICLE	NAME OF PUBLICATION
NONE			

21. EXTENT OF USE: PAST, PRESENT AND CONTEMPLATED (Give dates, places and other pertinent details)

NONE

22. DETAILS OF INVENTION HAVE BEEN RELEASED TO THE FOLLOWING COMPANIES OR ACTIVITIES

NAME AND ADDRESS	INDIVIDUAL OR REPRESENTATIVE	CONTRACT NO.	DATE
NONE			

SIGNATURE OF INVENTOR

DATE

12-6-79

(Attach to Record of Invention Part I)

REC. OF
INV. NO. 661 CS

This Disclosure of Invention should be written up in the inventor's own words and generally should follow the outline given below. Sketches, prints, photos and other illustrations as well as reports of any nature in which the invention is referred to, if available, should form a part of this disclosure and reference can be made thereto in the description of construction and operation.

See Pages 12 and 13 of the Fundamentals of Patent Technology SEES Circular No. 20.

1. INVENTORS NAME(S) HYLAND Y. L. CHEN

2. TITLE OF INVENTION AN OPTIC PROBE OF MYOCARDIAL VIABILITY

For answers to following questions use remainder of sheet, other side, and attach extra sheets if necessary.

3. GENERAL PURPOSE OF INVENTION. STATE IN GENERAL TERMS THE OBJECTS OF THE INVENTION.

4. DESCRIBE OLD METHOD(S) IF ANY, OF PERFORMING THE FUNCTION OF THE INVENTION.

5. INDICATE THE DISADVANTAGES OF THE OLD MEANS OR DEVICE(S).

6. DESCRIBE THE CONSTRUCTION OF YOUR INVENTION, SHOWING THE CHANGES, ADDITIONS AND IMPROVEMENTS OVER THE OLD MEANS OR DEVICES

7. GIVE DETAILS OF THE OPERATION IF NOT ALREADY DESCRIBED UNDER 6.

8. STATE THE ADVANTAGES OF YOUR INVENTION OVER WHAT HAS BEEN DONE BEFORE.

9. INDICATE ANY ALTERNATE METHODS OF CONSTRUCTION.

10. IF A JOINT INVENTION, INDICATE WHAT CONTRIBUTION WAS MADE BY EACH INVENTOR.

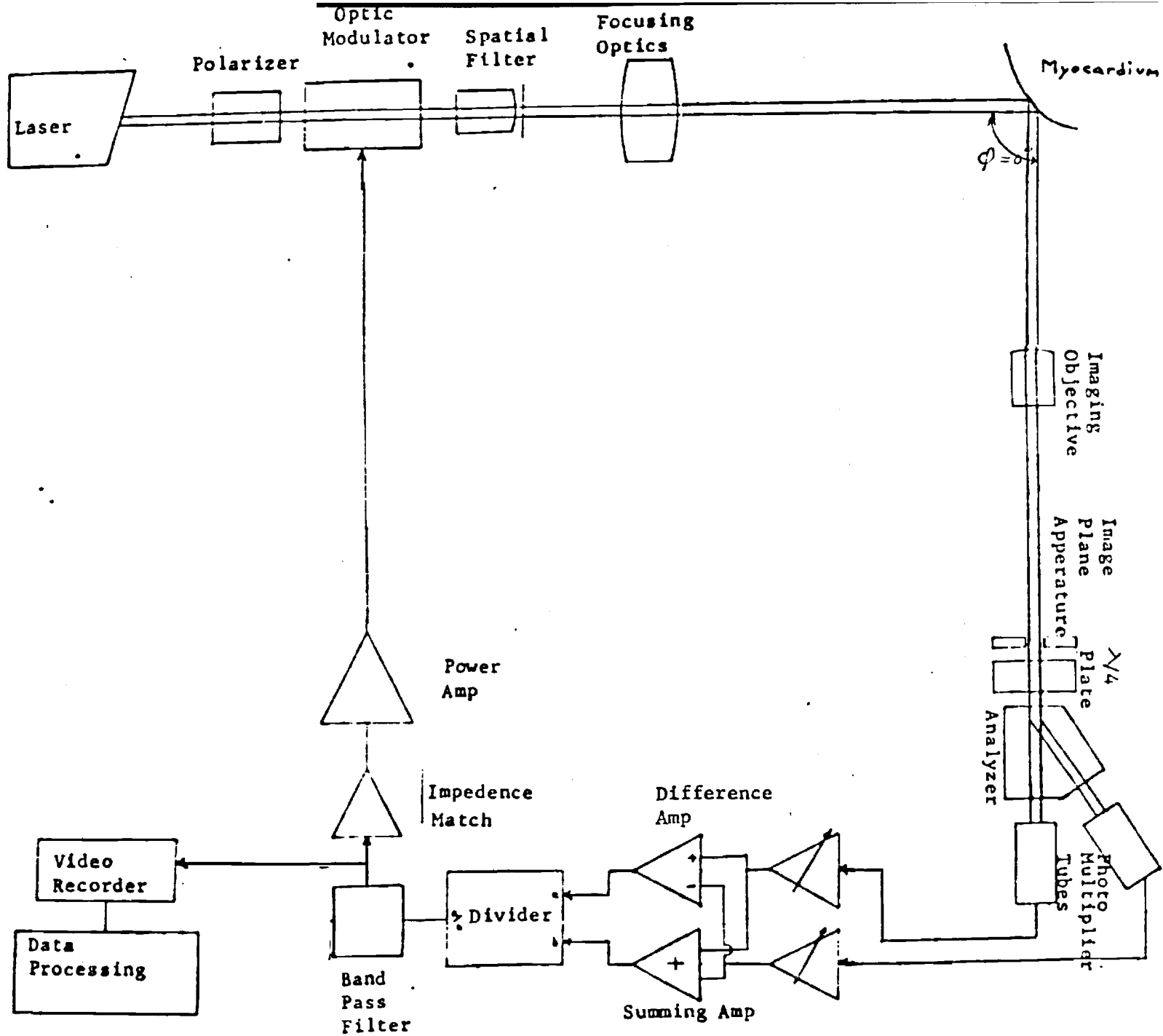
11. FEATURES WHICH ARE BELIEVED TO BE NEW.

12. AFTER THE DISCLOSURE IS PREPARED, IT SHOULD BE SIGNED BY THE INVENTOR(S), AND THEN READ AND SIGNED AT THE BOTTOM OF EACH PAGE BY TWO WITNESSES USING THE FOLLOWING STATEMENT:

"DISCLOSED TO AND UNDERSTOOD BY ME THIS-----DAY OF-----19---
SIGNATURE-----"

Disclosed to and understood by me this 11th day of November 1952

3. The purpose of the invention is to spatially pinpoint rigor, resting and active regions of myocardium in pathological conditions, such as cardiac infarction, to facilitate diagnosis and surgery by using an optic probe which picks up optical signatures in birefringence of these different regions. The electric activity of myocardium varies significantly with its states, and manifests itself in its birefringent properties accordingly.
4. & 5. In the case of open heart surgery for cardiac infarction, the infarcted regions are determined by x-ray angiography. The condition of the myocardium within the infarcted region, either rigor (dead), resting (due to lack of oxygen) or active is determined by inference or the guess of the surgeon. Finite element methods are under development to determine the infarcted region by spotting quantitatively the anomaly of the contraction, i.e. determining the condition of certain regions by mechanical observation, which is global.
6. & 7. As a laser beam passes through or scatters from muscle proper as an electromagnetic wave, the electrical activities such as membrane polarization and cross bridge orientation will differentially retard the field propagation. Thus a polarized laser beam will be depolarized. The collected beam will pass through an analyzer and register on light detectors to give a resultant time-phase shift curve. The birefringence of muscle during the course of contraction can then be probed by the time course of the depolarization, producing a distinct optic signature depending on the state of the muscle. A brief block diagram is attached as an example of a possible engineering design of the probe.
8. This method allows pinpoint (with spatial resolution in the order of 50 μ m.) determination of muscle viability, thus eliminating the uncertainty inherent in other methods.
9. The schematic represents only one possible utilization of the basic principle.
10. N/A



REC. OF
INV. NO. 661 CS

11. The optic probe tests muscle viability by a method which is categorically different from all classical methods.

INVENTOR

DISCLOSED TO AND UNDERSTOOD BY ME
ON THIS 6 DAY OF Sept 19 79

DISCLOSED TO AND UNDERSTOOD BY ME
ON THIS 6 DAY OF Sept 19 79