

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to fill in all appropriate spaces may cause your proposal to be disqualified.

TOPIC NUMBER: N90-378

PROPOSAL TITLE: Innovative Small Engine Concepts

FIRM NAME: Galileo Research

MAIL ADDRESS: P.O. Box 25

CITY: Torrington STATE: CT ZIP: 06790

PROPOSED COST: \$40,000.00 PHASE I OR II: 1 PROPOSED DURATION: 6
PROPOSAL IN MONTHS

- BUSINESS CERTIFICATION:**
- | | YES | NO |
|--|-------------------------------------|-------------------------------------|
| ▶ Are you a small business as described in paragraph 2.2? | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| ▶ Are you a minority or small disadvantaged business as defined in paragraph 2.3? | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| ▶ Are you a woman-owned small business as described in paragraph 2.4? | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| ▶ Will you permit the government to disclose the information on Appendix B, if your proposal does not result in an award, to any party that may be interested in contacting you for further information or possible investment? | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| ▶ Has this proposal been submitted to other US government agency/agencies; or DoD components, or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office in the spaces to the left below. If it has been submitted to another SBIR activity list the Topic Numbers in the spaces to the right below: | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

▶ Number of employees including all affiliates (average for preceding 12 months) one

PROJECT MANAGER/PRINCIPAL INVESTIGATOR CORPORATE OFFICIAL (BUSINESS)

NAME: Kenneth A. Galitello, Jr. NAME: _____

TITLE: President- Owner TITLE: _____

TELEPHONE: (203) 489-2991 TELEPHONE: _____

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: _____

DISCLOSURE PERMISSION STATEMENTS: All data on Appendix A are releasable. All data on Appendix B, of an awarded contract, are also releasable.

 6-26-90
SIGNATURE OF PRINCIPAL INVESTIGATOR DATE

SIGNATURE OF CORPORATE BUSINESS OFFICIAL DATE

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

APPENDIX B

TOPIC NUMBER: N90-378

PROPOSAL TITLE: Innovative Small Engine Concepts

FIRM NAME: Galileo Research

PHASE I or II PROPOSAL: 1

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Perform analytical assesment of an innovative Free Piston Two Stroke Cycle Engine, Patent # 4,876,991 promising to be multifuel capable, possess a high power output per size and displacement, is low on fuel consumption and emissions, is lightweight, easy to service and has a power output section capable of moving a fluid under pressure and/or generating AC electricity. Particular attention will be paid to Diesel fuel operation. The engine may be used as a generator, a pump, or both.

Anticipated Benefits/Potential Commercial Applications of the Research or Development

Benefits of research will be understanding compression ignition of a premixed air/fuel charge and flow characteristics in an injected (air & fuel) two stroke cycle engine. Further, commercial applications of a developed engine would result in whole new design concepts in equipment and vehicles.

List a maximum of 8 Key Words that describe the Project.

<u> Lightweight </u>	<u> Generator </u>
<u> High Power Output </u>	<u> Pump </u>
<u> Low Fuel Consumption </u>	<u> Multifuel Engine </u>
<u> Low Emissions </u>	<u> Two Stroke Engine </u>

Identification and Significance of the Problem or Opportunity

Present day diesel engines are heavy, have a relatively slow speed and emit pollutants that are not desirable for the health of personell. Their use is justified though, because they have a relatively high power output and use a small amount of fuel in accomplishing their work.

A great deal of research has been done in recent years to improve the diesel engine, make it more efficient and less polluting through ceramic parts and ceramic coatings of components within the combustion chamber. The reason ceramics are attractive is that they can withstand the extreme temperatures that other materials could not. Other reasons for using ceramics are they eliminate the cooling system, thereby making the engine Adiabatic which results in higher operating temperatures.

Theoretically, higher operating temperatures produce greater efficiency. According to the Laws of Physics, this is true. In a study by the Massachusettes Institute of Technology, SAE paper # 890570, their investigation into Adiabatic engines indicated that "compared to the metal engine, the insulated engine had a higher brake specific fuel consumption which was attributed to a slower combustion process." "To fully utilize the potential of the insulated engine, suitable redesign of the combustion system is needed."

This redesign is embodied in Patent # 4,876,991 whereby a premixed air/fuel charge is injected into the combustion chamber of each cylinder as its associated piston has just covered its exhaust port and is propelled to compression ignition by the kinetic energy generated from combustion in its opposed cylinder. Reference Drawing #'s 1 and 2.

Phase I Technical Objectives

To validate the design of Patent # 4,876,991 through theory and analytical assesment.

1. To create a set of detailed drawings of each component.
2. To isolate and model each major component (system) of the design through the Laws of Physics and Chemistry to determine validity.
 - A. The Combustion Process
 - B. Gas Dynamics
 - C. Thermodynamic Evaluation
 - D. The Starting System
 - E. The Power Transfer System
 - F. Overall Engine Dynamics

Phase I Work Plan

Upon acceptance of the proposal and a retainer submitted by the DoD the principal investigator shall leave his full-time employment at The Torrington Company, Test Lab, establish an office, obtain the desired equipment (computer for modeling) and hire an undergraduate or graduate student to assist in the project. This should occur within the first two weeks.

The next month thereafter, will be devoted to creating a set of drawings to model the engine.

At one and one-half months, modelling of gas dynamics and the combustion process will commence along with thermodynamic evaluation. This is the main thrust of the project in which two to three months are allotted. If more time is needed, other areas of analysis such as starting and power transfer shall be deleted.

It is estimated that at four months into the project, analysis of the starting system, power transfer system and overall engine dynamics should commence.

The final two weeks shall be dedicated to compiling information and writing a report.

ITEM

SETUP							
	DRAWINGS						
		COMBUSTION MODELING					
			SYSTEMS MODELING				
					REPORT		
I	I	I	I	I	I	I	I
0	1	2	3	4	5	6	
			<u>MONTHS</u>				

The principal focus of the project will be to show that the new combustion system which injects air and fuel into the combustion chamber and is then brought to spontaneous combustion through compression, can accomplish complete combustion with the effects of ultra low emissions, low thermal conductivity and a relatively high power output per displacement.

Computer modeling from drawings done within the first month will be achieved through gas flow analysis, thermodynamic and gas-dynamic behavior, physics of a moving projectile, and chemistry of combustion all of which have formulas that are programmable into a computer which replicates actual conditions.

Related Work

The principal investigator has spent the past ten years researching and developing the Bourke Engine on a part time basis. In 1982 one of Russell Bourke's original prototypes was obtained and studied. Examination of the engine and its components led to the adaptation of electronic fuel injection along with redesigning some of the weak parts that tended to break under stress. After recognizing the limitations of the Bourke engine, the PI set out to create a new and innovative engine that eliminates the flaws and drawbacks of today's internal combustion engines. The resultant design is seen in Patent # 4,876,991 titled "Two Stroke Cycle Engine", issued in October 1989.

In past research, other work was noted by the Jarret brothers from France, US Patent # 4,154,200 for a free piston engine. In an article published by Popular Science magazine in June 1980, testing shows that the engine has vibrationless operation and "though it shares diesel fuel and compression ignition with diesel engines, it does not follow the diesel thermodynamic cycle." "Tests indicate the combustion process is 90 percent efficient."

Another inventor in West Germany named Stelzer, US Patent # 4,385,597 for a Two Stroke Engine, has claims similar to Jarret that the engine is a free piston type and produces amazing results. Both of these engines achieved a high power output, low pollution level and are currently under development.

Compact and Lightweight Generators are being explored by the DoD as seen in DTIC Report summaries (Accession numbers DA318388 and DA318430).

Work is being done throughout the US on Adiabatic Engines by more than a dozen Business' and Universities.

The Principal Investigator has recently established GALILEO RESEARCH for continued development of Patent # 4,876,991, and is a sole proprietor.

Relationship with Future Research or Research and Development

1. Upon successful results of Phase I research, construction of a prototype will be initiated and testing to prove theory and analysis will be conducted.
2. Phase I research is essential to the development of a prototype. Analysis and modeling will determine the best design for components and give an excellent indication on the performance characteristics. It will give an excellent place to start when the prototype is made and will eliminate a considerable amount of guesswork. Also, potential investors would be more confident and further stimulated with successful results of the Phase I analysis.

Potential Post Applications

1. The introduction of a small portable lightweight powersource with low fuel consumption and low emissions may have a great impact on the Federal Government, in that current fuel usage would be cut drastically resulting in a great savings. Not only is this a good opportunity for the DoD to save on fuel, but vehicles and equipment may be updated through new design capabilities offered by this new technology. The Nation as a whole will experience a reduction in pollution and our National Debt will improve from a reduction in imports.
2. Commercial applications are too numerous to mention as the successful demonstration of a prototype would affect all areas of equipment and vehicles (Land, Sea, Air & Space) in that new design capabilities would result from a small portable powersource that may be placed anywhere in a vehicle or machine and power takeoff lines run from the engine to wherever it is that energy is needed.

Key Personell

Principal Investigator - Kenneth A. Galitello, Jr.
P.O. Box 25
Torrington, CT 06790

Associate in Science Degree
Northwestern Connecticut Community
College

10 years experience in Two Stroke
Research and Development.

Member - Society of Automotive
Engineers

Patent # 4,876,991

Kenneth A. Galitello, Jr.
 P. O. Box 25
 Torrington, CT 06790
 (203) 489-2991

OBJECTIVE

To promote continued research and development of Patent
 # 4,876,991.

QUALIFICATIONS

R&D Data Analysis	Production Management
Computer Programming	Supervise Production
Fortran	Production Planning
Pascal	Production Standards
Technical Writing	Process Planning
Internal Combustion Engineering	Quality Control and Testing
Prototype Development	Inventory Control
Drafting	Shipping and Receiving
Machine Setup and Operate	Laboratory Testing
Patent Development	Apartment Rental Management
Business Management	General Contracting

EDUCATION

Associate in Science Degree
 Northwestern Connecticut Community College,
 Winsted, CT
 Courses included: Accounting, English Literature,
 Writing, Computer Programming, and Mathematics.

The University of Connecticut, Torrington, CT 06790
 Courses included: Engineering I, Chemistry, Physics,
 Computer Engineering, Computer Programming, and
 Economics.

WORK EXPERIENCE

1990- Galileo Research, Torrington, CT 06790
 President/Owner: Formed Galileo Research to
 continue research and development of Patent
 # 4,876,991.

1989- The Torrington Co., Inc., Torrington, CT 06790
 Test Lab Technician: Perform inspection, testing
 and evaluation of standard and experimental
 bearings. Submit reports to and work closely with
 Engineering.

1985-1987 American Backplane Inc., Goshen, CT 06756
 Production Manager: Supervised and managed all
 areas of manufacturing.

INTERESTS

Research and Development of Advanced High Performance Internal
 Combustion Engines. Patent # 4,876,991 issued 10-31-89
 entitled "Two Stroke-Cycle Engine".

Key Personell - continued

Graduate or undergraduate student specializing in the area of internal combustion to be selected at the appropriate time.

Facilities/Equipment

Office and equipment (computer capable of running engineering programs and 3D CAD) will be obtained at the acceptance of this proposal. The facilities shall meet all Federal, State and Local Laws.


Consultants

Outside consultants will not be used unless recommended by DoD.

Prior, Current or Pending Support

No prior, current or pending support for a similar proposal.

U.S. DEPARTMENT OF DEFENSE
 SMALL BUSINESS INNOVATION RESEARCH PROGRAM
 PHASE I-FY1990
 COST PROPOSAL

1. Name of offeror: Kenneth A. Galitello, Jr.
2. Home office address: P.O. Box 25 Torrington, CT 06790
3. Location where work will be performed: To be determined.
4. Title of proposed effort: Innovative Small Engine Concepts
5. Topic Number: N90-378
6. Total dollar amount of the proposal: \$40,000.00
9. Direct labor - Type: Research
 Estimated Hours: 520
 Rate per Hour: \$50.00
 Total Estimated Direct Labor: \$26,000.00
15. Other Direct Costs: Rent \$3,000.00
 Telephone \$1,000.00
 Total Estimated Direct Costs: \$ 4,000.00
18. Fee or Profit: \$10,000.00
19. Total Estimate Cost and Fee \$40,000.00
20.  Date 6-26-90
 Kenneth A. Galitello, Jr. - President/Owner Galileo
 Research
21. a. no
 b. no
 c. yes Progress Payments
22. Cost plus Fixed Fee Contract

[54] TWO STROKE CYCLE ENGINE

[76] Inventor: Kenneth A. Galitello, Jr., P.O. Box 25, Torrington, Conn. 06790

[21] Appl. No.: 281,530

[22] Filed: Dec. 8, 1988

[51] Int. Cl.⁴ F02B 71/00

[52] U.S. Cl. 123/46 E

[58] Field of Search 123/46 R, 46 E; 417/364.

[56] References Cited

U.S. PATENT DOCUMENTS

2,091,547	8/1937	Jalbert	123/195 R
2,814,551	11/1957	Broeze et al.	123/46 R
2,944,535	7/1960	Fikse	123/46 R
3,214,085	10/1965	Boldt	123/46 R
3,370,576	2/1968	Huber	123/46 R
3,643,638	2/1972	Braun	123/46 R
3,675,031	7/1972	Lavigne	123/46 E
3,986,796	10/1976	Moiroux et al.	123/46 R
4,112,683	9/1978	Bess	123/46 R
4,308,720	1/1982	Brandstadter	123/46 R
4,362,477	12/1982	Patten	417/364
4,450,685	5/1984	Corey	60/517
4,462,345	7/1984	Routery	123/46 E
4,480,599	11/1984	Allais	123/46 R
4,532,431	7/1985	Iliev et al.	123/46 R
4,776,166	10/1988	Dixon	123/46 R

FOREIGN PATENT DOCUMENTS

2755434 6/1979 Fed. Rep. of Germany 123/46 E

Primary Examiner—David A. Okonsky
Attorney, Agent, or Firm—Richard A. Craig

[57] ABSTRACT

A free-piston two stroke cycle engine includes a piston rod assembly having a connecting rod with first and second ends, first and second power pistons affixed to the ends of the rod and first and second power transfer pistons mounted on the rod between the power pistons at locations spaced from each other, first and second power cylinders with sealed cavities in which the power pistons are movable. The cavities and the power pistons provide precompression chambers and combustion chambers of varying volumes. A timing module is located between the power cylinders, and first and second power transfer modules, each including a power transfer cylinder are between the timing module and the first and second power pistons, respectively. The connecting rod passes through the timing module and the power transfer modules and the first and second power transfer pistons reciprocate within the power transfer cylinders. The engine also includes gating and valving devices as appropriate, as well as a computer for controlling various aspects of the operation of the engine.

25 Claims, 6 Drawing Sheets

