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310/10

**Economic Development for Physicists from Developing Countries**

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# *INVENTION TO PRODUCT: TIME-LINES AND PROCESS-LINES*

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**Economic Development for Physicists**

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**ICTP, Trieste, Italy**

# Invention to Product: Time-Lines and Process-Lines

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**U.S.A.**

# Introduction

Inventions result from research with utility and need in mind.

**Context-based research:**
Typically Industrial Research
Example: New plastics in plastics industry, new cancer drugs in pharmaceutical industry. Requirements are somewhat known.

**Context-free research:**
Typically University Research
Example: Molecular Beams
Microwave heating?

Generally, we have faster development of products from context-based research.

## What are you inventing?

New Technology?

*"Technology is a capability that can be used in a product."*

*Nuclear Magnetic Resonance, superconducting materials, lasers, radars…...*

OR

A New Product?

*"makes use of existing technologies"*

MRI, low-loss electrical transmission systems, optical readers/scanners, laser-based eye surgery systems …….

A new product has a customer and a market in mind

## Technology Readiness Levels (TRL)

Developed by NASA and commonly used in the US for technology development programs.

Ref: www.nasa.gov

# Technology Readiness Levels (TRL)

| | |
|---|---|
| **TRL 1** | Lowest level of technology readiness. Research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties. |
| **TRL 2** | Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies. |
| **TRL 3** | Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative. |
| **TRL 4** | Basic technological components in the intersect areas are ***integrated in a similar fashion*** to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory. |
| **TRL 5** | Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components. |
| **TRL 6** | ***Similar but not necessarily the same system***, which is well beyond that of TRL5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include reliability and satisfactory performance characteristics in a high fidelity laboratory environment or in simulated operational environment (operating range of temperature, humidity, pressure, etc.) |
| **TRL 7** | Prototype near or at planned operational system. Represents a major step up from TRL6, requiring demonstration of an actual system prototype in an operational environment. Examples include testing the prototype in a mock-up of the final product. |
| **TRL 8** | Technology proven to work in its final form and under expected conditions. In most cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended environment to determine if it meets specifications. |
| **TRL 9** | Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions. |

## Things to take care of when working on an invention

## 1) Invention Notebooks

## Reference

http://www.bookfactory.com/special_info/invent_notebook_guidelines.html

Record as clearly as possible the purpose of the work, the methodology, the results, data and inferences regularly, ***date it and have it witnessed.***

Typical inventor's notebook and entries

# Inventor’s Notebook Details

**(Ref: http://www.bookfactory.com/special_info/invent_notebook_guidelines.html)**

Your Inventor's Notebook is a vital record of your work whether it is for patent purposes, or legal records. The Inventor's Notebook can help you prove:

Exact details and dates of conception

Details and dates of reduction to practice

Diligence in reducing your invention to practice

Details regarding the structure and operation of your invention

Experimentation observations and results

A chronological record of your work

Other work details

# Inventor’s Notebook Entries: few simple rules of thumb

**(http://www.bookfactory.com/special_info/invent_notebook_guidelines.html)**

Always record entries legibly, neatly and in permanent ink.

Immediately enter into your notebook and date all original concepts, data and observations, using separate headings to differentiate each.

Record all concepts, results, references and other information in a systematic and orderly manner. (Language, charts and numbering systems should be maintained consistently throughout.)

It is acceptable to make your entries brief. Always, however, include enough details for someone else to successfully duplicate the work you have recorded.

Label all figures and calculations.

**Never, under any circumstances, remove pages from your notebook.**

Remember to treat your Inventor's Notebook as a legal document: It records the chronological history of your activities.

# Inventor's Notebook Entries

Start entries at the top of the first page, and always make successive, dated entries, working your way to the bottom of the last page.

After completing a page, sign it before continuing to the next page.

Make sure that you record the date of each entry clearly and unambiguously.

Never let anyone other than yourself write in your Notebook (excluding witness signatures, discussed later).

Never leave blank spaces, and never erase or remove material you have added. Simply draw lines through any blank spaces at the same time you are making your entries.

Do not erase errors. Just draw a single line through any erroneous entry, then add your initials. Enter the correct entry nearby.

You can supplement your entries with supporting material (e.g., test-result printouts and other documentation). But you must permanently affix the material onto a page in its proper chronological location.

Never rely solely on any supplemental attachment. Always include your own entry describing the attachment and add any conclusions that you might draw from its substance.

Occasionally, secondary sources might be too large or inappropriate to attach directly to your notebook. In this case, you can add all secondary sources to an ancillary record maintained precisely for this purpose. However, always remember to write a description of these secondary sources, clearly and unambiguously, in your notebook.

## Things to take care of when working on an invention (continued)

2) Think of ***products*** that can be developed using the invention. Your invention/product can stand on its own or be a part of others' product or it can be a system. Egs. non-invasive pressure sensor – continuous blood pressure monitor

3) **Connect yourself** to the markets in the field of invention and possibly other related areas.

**What do you do after you think you have an invention?**

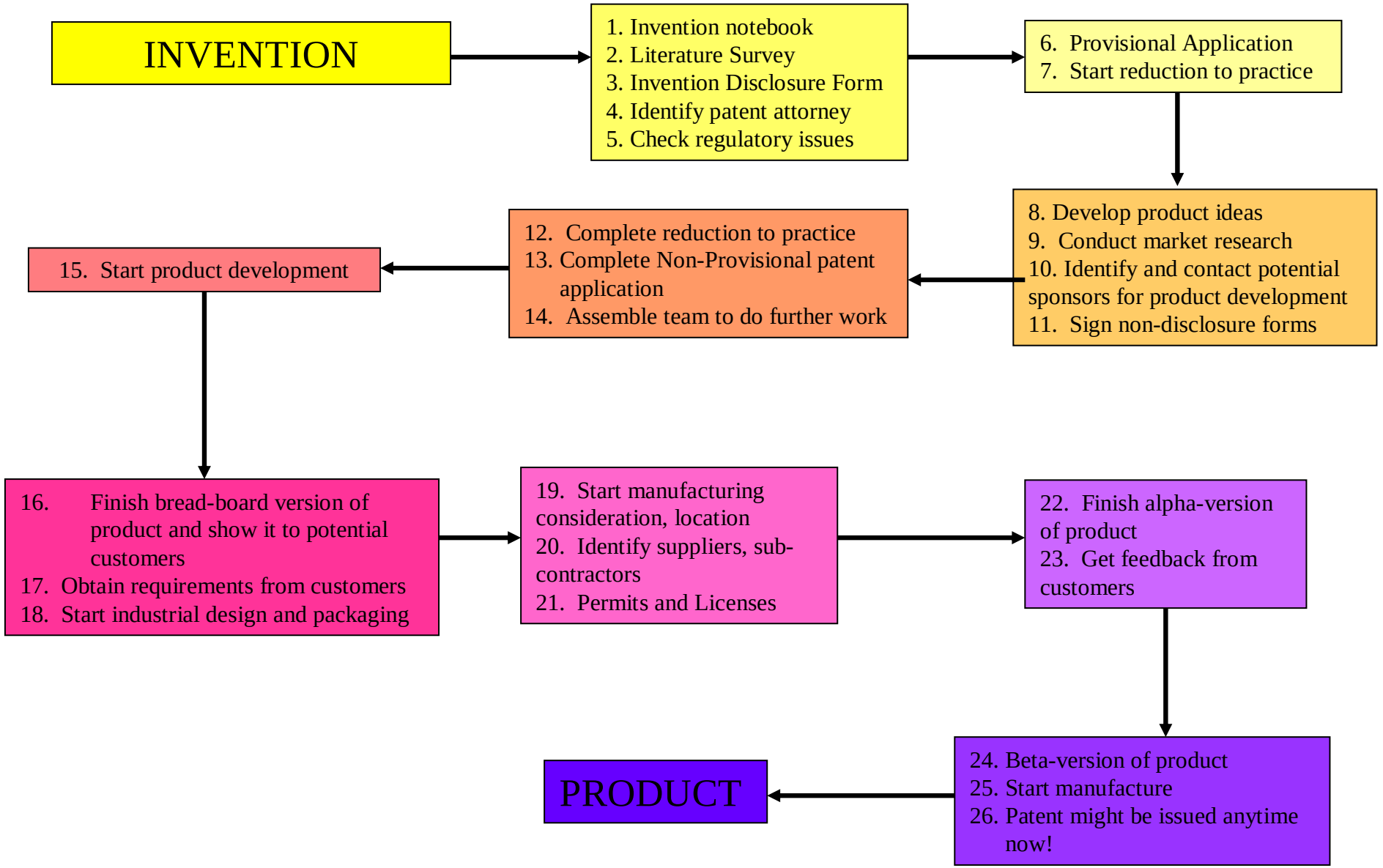
**Two different strategies:**

a) Develop the product by yourself or

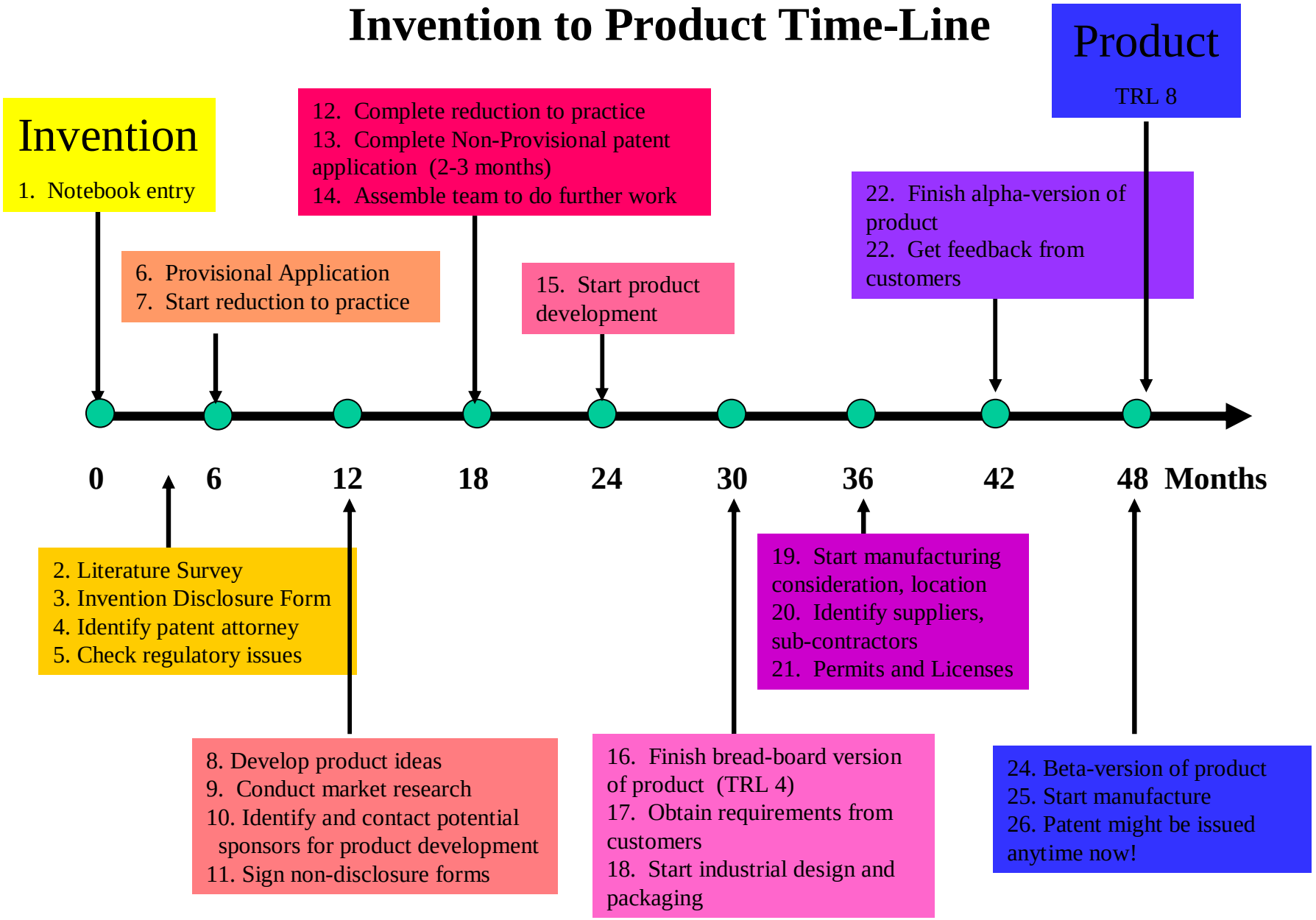
b) License the invention to others

The steps in the next few slides are common for both – either you or someone else has to do that!

# Invention to Product Process-Line



# Invention to Product Time-Line

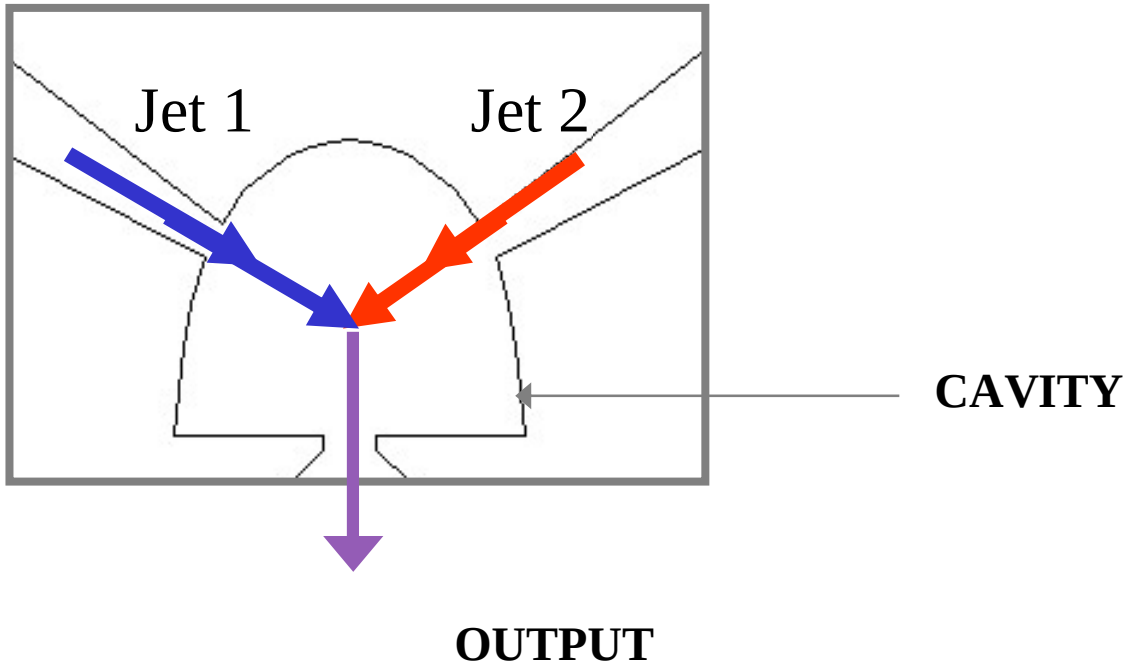


## Examples:

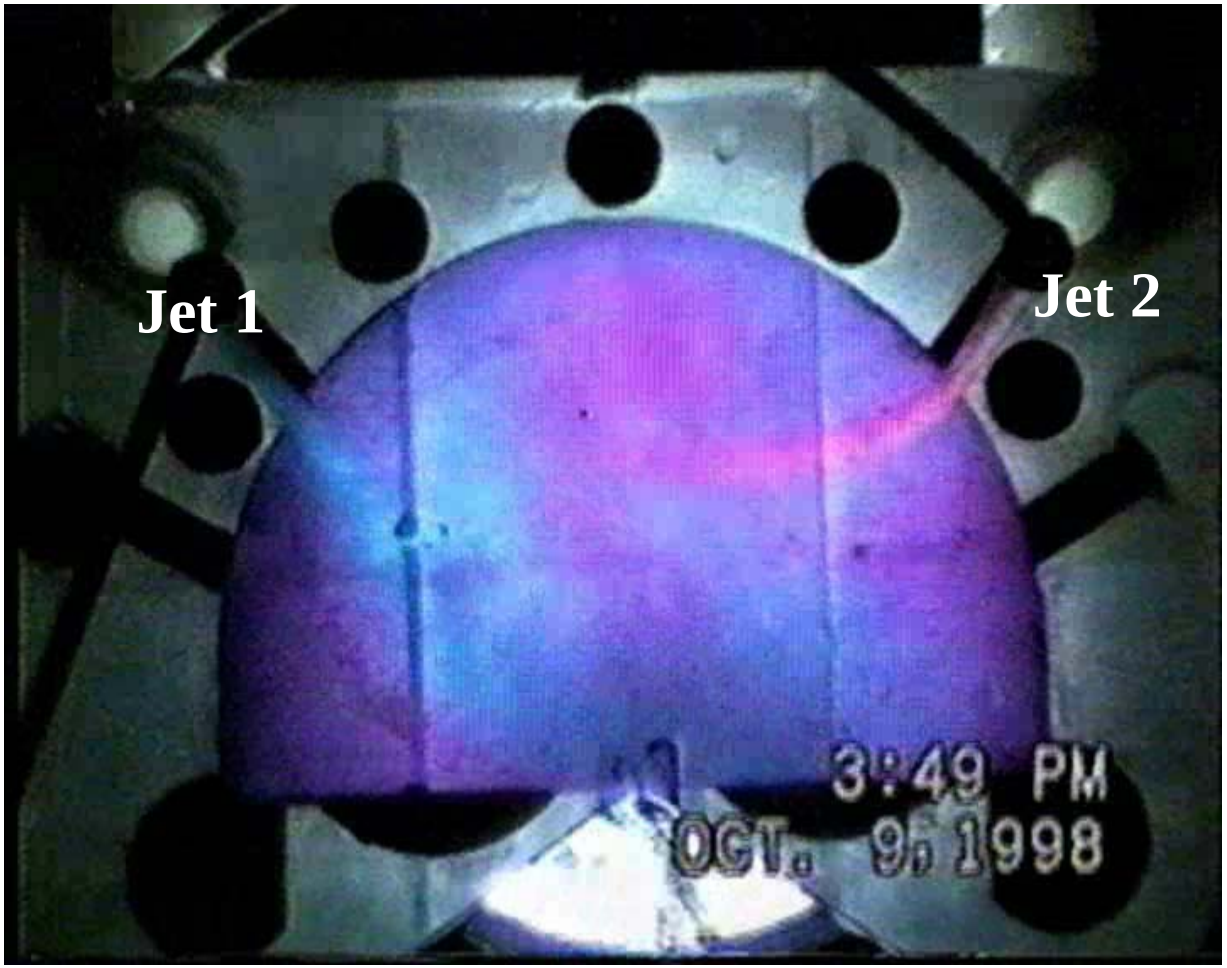
1. Windshield washer nozzles based on hydrodynamic instabilities

## Twin-Jet Fluidic Oscillators

(Raghu, US Patent 6,253,782, 2001)



# Flow visualization of jet instability using color dyes in water




**Reduction to practice**

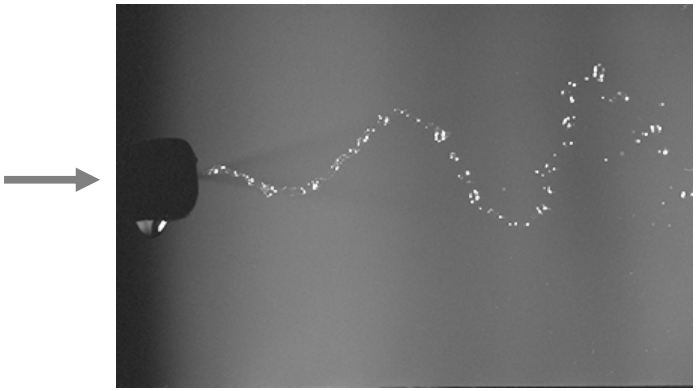
Jet 1 and Jet 2 size: 6 mm x 6 mm; Re ~ 1000

# Product Development

**Develop Product Idea**

**---- Spray device**

# Oscillating jet (spray) generated by the device



# The Final Product: Windshield Washer Nozzle

40 million

nozzles/year

US006253782B1

(12) **United States Patent**
**Raghu**

(10) **Patent No.: US 6,253,782 B1**
(45) **Date of Patent: Jul. 3, 2001**

(54) **FEEDBACK-FREE FLUIDIC OSCILLATOR AND METHOD**

(75) Inventor: **Surya Raghu**, Ellicott City, MD (US)

(73) Assignee: **Bowles Fluidics Corporation**, Columbia, MD (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/417,899**

(22) Filed: **Oct. 14, 1999**

**Related U.S. Application Data**

(60) Provisional application No. 60/104,511, filed on Oct. 16, 1998.

(51) **Int. Cl.**[7] ..... **F15C 1/06**

(52) **U.S. Cl.** ..... **137/14**; 137/809; 137/810; 137/811; 137/813; 137/826; 137/833; 137/835

(58) **Field of Search** ..... 137/826, 833, 137/835, 808, 809, 810, 811, 812, 813, 14

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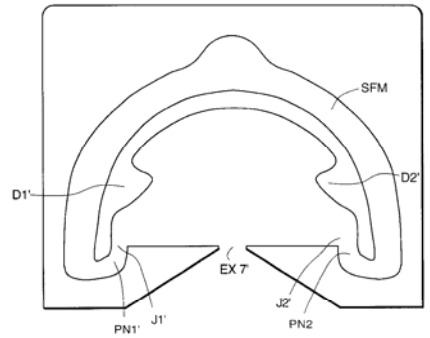
*Primary Examiner*—A. Michael Chambers
(74) *Attorney, Agent, or Firm*—Jim Zegeer

(57) **ABSTRACT**

A fluidic oscillator includes a member having an oscillation inducing chamber, at least one source of fluid under pressure, at least a pair of power nozzles connected to the at least one source of fluid under pressure for projecting at least a pair of fluid jets into the oscillation chamber, and at least one outlet from the oscillation chamber for issuing a pulsating or oscillating jet of fluid to a point of utilization or ambient. A common fluid manifold connected to said at least a pair of power nozzles. The shape of the power nozzle manifold forms one of the walls of the interaction or oscillation chamber. In some of the fluidic circuits, the length can be matched to fit existing housings. The power nozzle can have offsets which produce yaw angles in a liquid spray fan angle to the left or right depending on the direction desired. In some embodiments, the exit throat is off axis (off the central axis of the symmetry) by a small fraction to the left or right to move the leftward or rightward yaw angles in the spray. The outlet throat may be offset along the longitudinal axis by a small amount to produce a yaw angle of predetermined degree to the left or right depending on what is desired. Thus, one can construct circuits for yaw using a combination of the techniques described above which suits most applications.

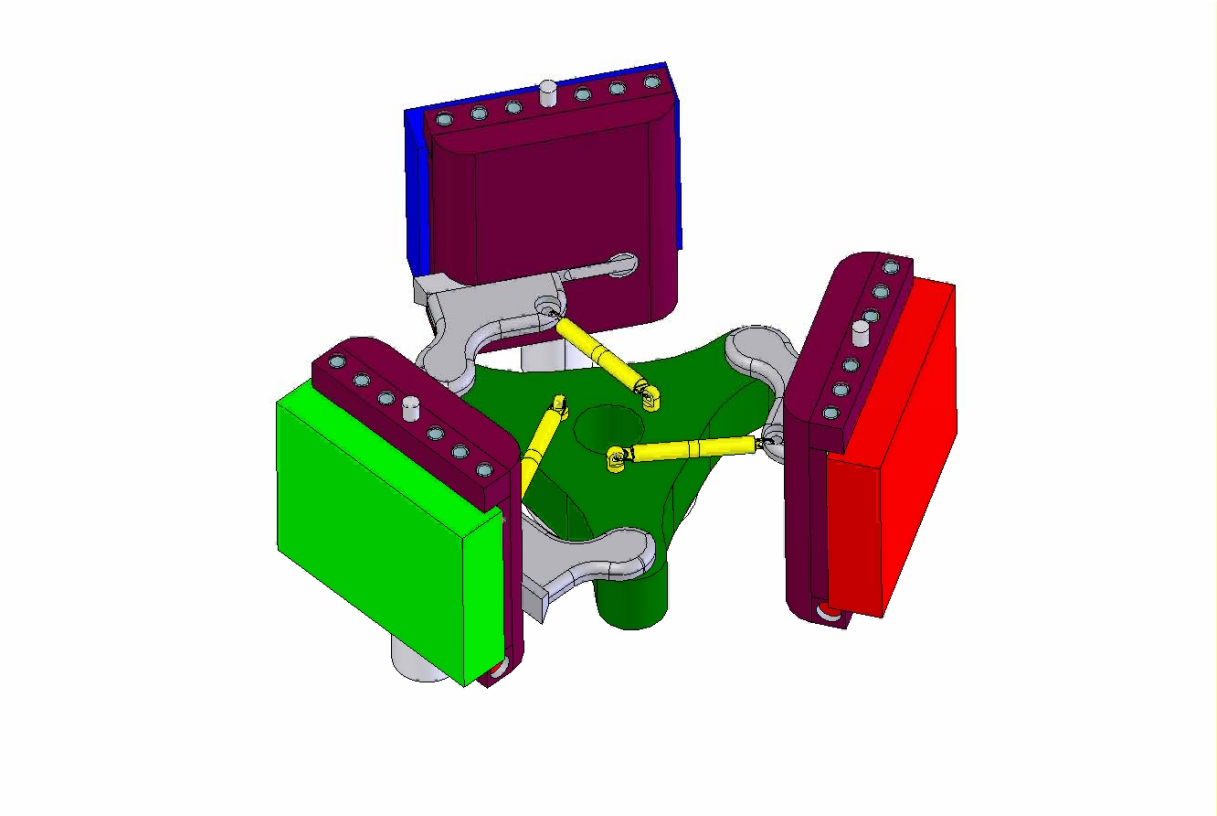
**25 Claims, 15 Drawing Sheets**



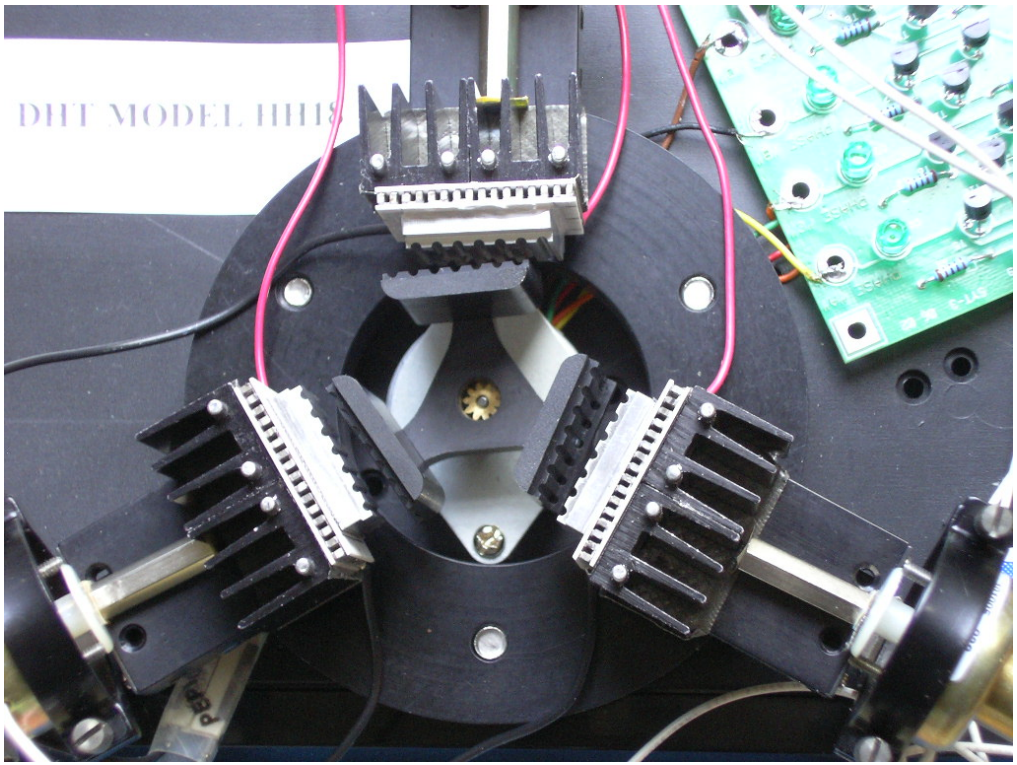
# Rotary Thermal Cycler for DNA Testing – Concept

# Tony Gutierrez, US Patent 6,875,602, April 5, 2005

# Monitoring of vector-borne diseases

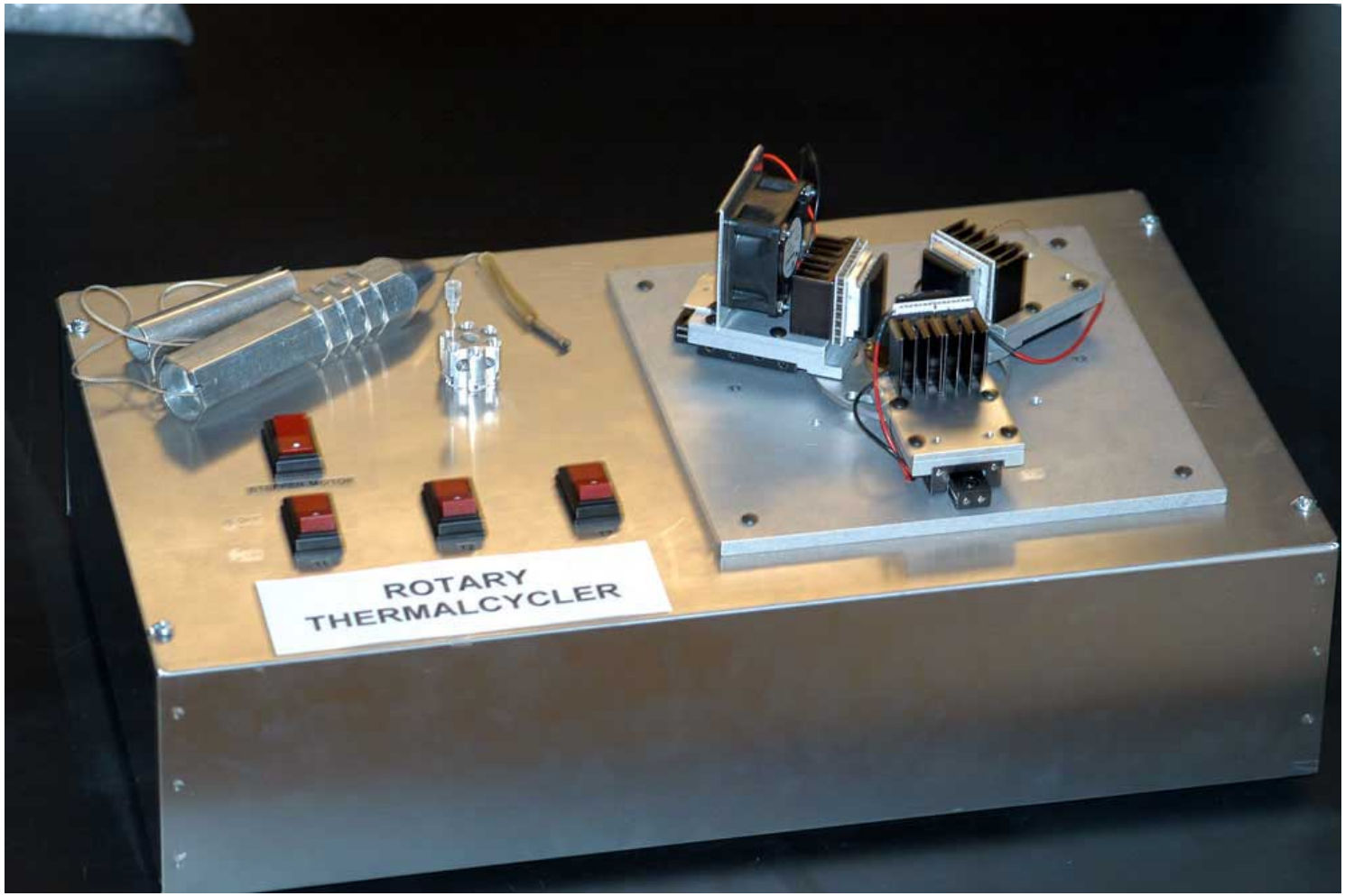


# Reduction to Practice – Breadboard design



# Rotary Motion Movie

# First Prototype: November 2006



Anticipated final product – 18-24 months from this stage.

Cost of development ~ $ 3-5 million

**“Failures”**

Reinvented the wheel

Ideas that did not work in reality

Ideas worked but no applications (products)

Found applications but products not successful in market

Products successful only for a short time – technology outdated

Are these experiences bad?

NO!

# Exit Strategies

Be ready to quit anytime for good reasons – no emotional attachment!

Be realistic!  Cannot pursue for ever if not working out.

Inventor's syndrome "Everything is mine"  – does not work always! At some point someone else has to take over the project.

Sell off the patent/IP/company at the right time

# Challenges for Inventors and Entrepreneurship in Developing Countries

1. Poor physical infrastructure
2. Lack of government and institutional support
3. Lack of planning and metrics for progress
4. Societal, cultural and moral factors on inventions
5. Societal and cultural taboos on failure

**How do we promote inventions and innovation in scientific and educational institutions?**

1. University-Industry interaction.

   Example: Presentation of Industrial R&D needs to Universities so that researchers will see the market needs.

   (Long Island Utility Industry – RD&D Day)

2. Industry sponsored projects to students and faculty

3. Industrial internships for students and faculty

4. Encouragement – it is OK to fail!

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