BOURDON TUBE EXPERIMENTS

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PREFACE

This investigation is intended as a stepping stone to methods significantly addressing the Climate Change issue. We wish to partner with the R & D division of a major manufacturer, regularly using bourdon tubes, based on three scientific facts they currently accept.

A supporting letter from Dr. Gorber, past President of SENES Consultants (energy scientists), regarding an associated patented invention (link to patent offices page 2), concludes with:

"I believe that Mr. Strain's invention will advance the scientific community's understanding of thermodynamics relating to pressurized fluids and energy to a new level. If fully developed the invention has the potential to reduce energy and as a result a reduction in the use of fossil fuels, thus assisting in the battle against climate change."

Practical application must be finalized. To survive together, we must work together.

The three accepted facts are:

1) Pascal's Principal (page 5) is valid respecting fluid pressure in a contained volume.
2) The volume of a bourdon tube does not change on being pressurized. (Industry experts contacted confirm this fact or state they have no data on this matter.)
3) The tip of a bourdon tube exerts a force at its tip as it travels through a distance.

The three facts combine into a concept challenging physical laws. When the potential working capability of a bourdon tube with a lesser range exerts its force on the non-compressible surface of a second bourdon tube, with a higher range, the work output of the second bourdon tube is greater than the work output of the first bourdon tube. (illustrated page 13)

The concluding fact is Work input < Work output. ($W_{input} < W_{output}$)

I urge you to consider the basis for accepting the physical laws established in the 1800's. If the claim is made that anything is unachievable, those making such claims must have all knowledge regarding the subject; past, present and future.

There are two recently patented inventions directed at challenging these laws. (Patent office links page 2). I'm quite confident the men from the 1800's did not time travel and refute inventions that challenge their claims. Multiple engineers/scientists/professors have assessed the inventions, which contest the opinion from the 1800's, but their current challenges contained nothing more than statements of blind faith in the "Laws" or a no contest position. None refuted the mechanical design, control circuitry or logic in the reports given to them.

Quoting Einstein: " *A foolish faith in authority is the worst enemy of truth.*"

If the scientific community does not adjust to thinking creatively and support their opinions with actual science, humanity is headed for disaster.

CONTENTS

BOURDON TUBE

WORK IN < WORK OUT ASSESSMENT

RESEARCH APPROACH

-1- Assess if the volume of a bourdon tube changes on pressurization.

-2- Investigated current engineering and scientific knowledge on the subject.

-3- Investigated other attempts of identifying bourdon tube characteristics.

-4- Formulated experiments to determine bourdon tube characteristics.

THE BOURDON TUBE EXPERIMENT

-1-The need was to provide an alternate and simple demonstration, supporting the diamond-shaped actuator patent (page 2), suggesting that the Laws of Thermodynamics have over-looked important fluid relationships, regarding energy/ mechanical work.

Successful experiments would also confirm Pascal's Principle. (pages 3, 4 and 5)

The intent was to determine if a bourdon tube with a lesser pressure range than a second bourdon tube will produce enough work at its tip to pressurize the second bourdon tube, producing work at the tip of the second bourdon tube greater than the work of the first bourdon tube.

-2 We contacted many gauge manufacturers to determine if the volume of a bourdon tube changed when being pressurized and depressurized. A few thought the volume did not change: most had no data on the matter.

-3- Cynthia Conway in her 1995 Engineering Masters thesis investigated the question regarding bourdon tube characteristics. She was required to assume the volume changed as she found no conclusive data on the matter after extensive investigation (page 18). The concluding result is that it appears unknown if the volume changes in a bourdon tube when pressurizing and de-pressurizing. View Cynthia Conway's full Thesis at https://core.ac.uk/download/pdf/36724053.pdf

-4- If the volume does not change or changes less than the submersed volume of a plunger forced into the bourdon tube's fluid (illustrated page 13), a demonstration may be presented proving that work input < work output ($W_{in} < W_{out}$), which contradicts the Laws of Thermodynamics.

The adaptation compensating for small volume changes is addressed in the patent, "PATENT USING BOURDON TUBE CHARACTERISTICS" (pages 2, 13 and 14).

Preparation for the experiments include:

-a- obtaining materials required for testing. (page 2,7,11)
-b- obtaining information from the NASA site addressing Pascal's Principle. (page 4)
-c- preparing an illustration of Pascal's Principle as it relates to bourdon tubes. (page 5)
-d- design a method of assessing Pascal's Principle. (page 13)
-e- design a method of measuring the varying force at the tip of a bourdon tube.(page 7)
-f- design a method of measuring the varying displacment at the tip of a bourdon tube.(page8)
-g- design a method of testing if a bourdon tube changes volume on pressurization. (page10)
-h- design a method of demonstrating Work input < Work output (page 13)

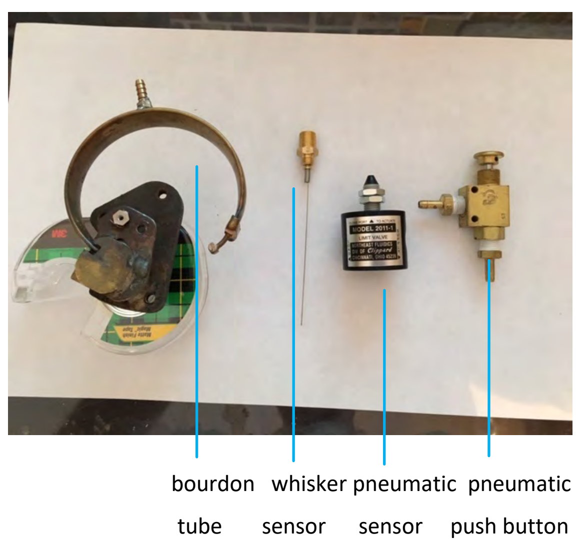
PATENT using bourdon tube characteristics

http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PALL&p=1&u=%2Fnetahtml%2FPTO%2Fsrchnum.htm&r=1&f=G&l=50&s1=7467517.PN.&OS=PN/7467517&RS=PN/7467517

PATENT regarding the Diamond-shaped fluid powered linkage, system and engine

https://worldwide.espacenet.com/inpadoc?submitted=true&DB=EPODOC&CC=US&NR=2002178719&KC=&F=8&OREQ=0&textdoc=TRUE&FT=E

SPECIALIZED COMPONENTS FOR EXPERIMENTS



Regarding the experiment presented on page 10;

Testing determined that the push buttons required too much force to use them in the experiment.

Testing determined that the pneumatic proximity sensors were not satisfactory for the experiments.

Testing determined that the pneumatic whisker sensors were the best option for the experiments.

PASCAL

Pascal (19 June 1623 – 19 August 1662) was a significant scientist advancing the knowledge of mankind in the fluidics field and more.

PASCAL'S PRINCIPLE

"*A change in pressure applied to an enclosed fluid is transmitted undiminished to all portions of the fluid and to the walls of its container."*

Page 4 was obtained from the NASA WEB site which presents the basic understanding of Pascal's Principle.

Page 5 presents the relationship of Pascal's Principle in a practical application to bourdon tubes in gauges.

Understanding Pascal's Principle at a very practical level is imperative inorder to grasp this fluidic advancement.

Pascal's Principle and Hydraulics

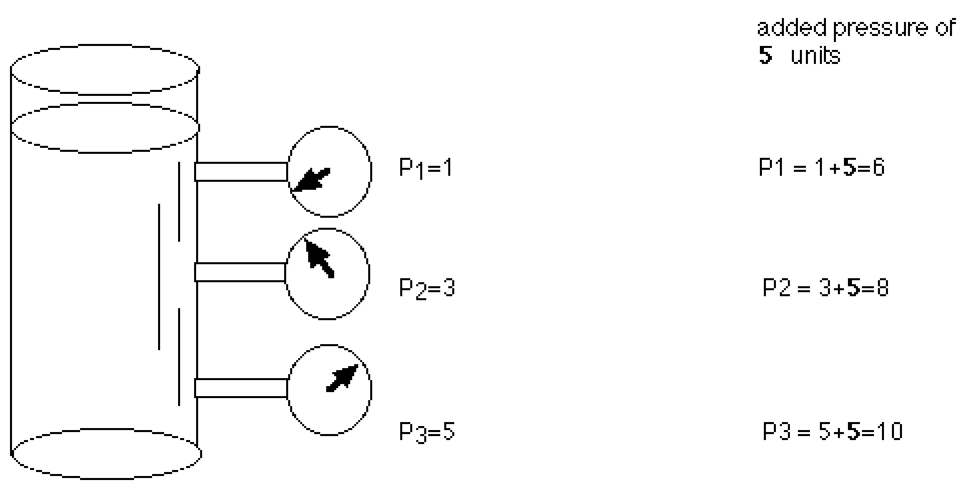
SUBJECT: Physics
TOPIC: Hydraulics
DESCRIPTION: A set of mathematics problems dealing with hydraulics.
CONTRIBUTED BY: Carol Hodanbosi
EDITED BY: Jonathan G. Fairman - August 1996

Hydraulic systems use a incompressible fluid, such as oil or water, to transmit forces from one location to another within the fluid. Most aircraft use hydraulics in the braking systems and landing gear. Pneumatic systems use compressible fluid, such as air, in their operation. Some aircraft utilize pneumatic systems for their brakes, landing gear and movement of flaps.

Pascal's law states that when there is an increase in pressure at any point in a confined fluid, there is an equal increase at every other point in the container.

A container, as shown below, contains a fluid. There is an increase in pressure as the length of the column of liquid increases, due to the increased mass of the fluid above.

For example, in the figure below, P3 would be the highest value of the three pressure readings, because it has the highest level of fluid above it.



If the above container had an increase in overall pressure, that same added pressure would affect each of the gauges (and the liquid throughout) the same. For example P1, P2, P3 were originally 1, 3, 5 units of pressure, and 5 units of pressure were added to the system, the new readings would be 6, 8, and 10.

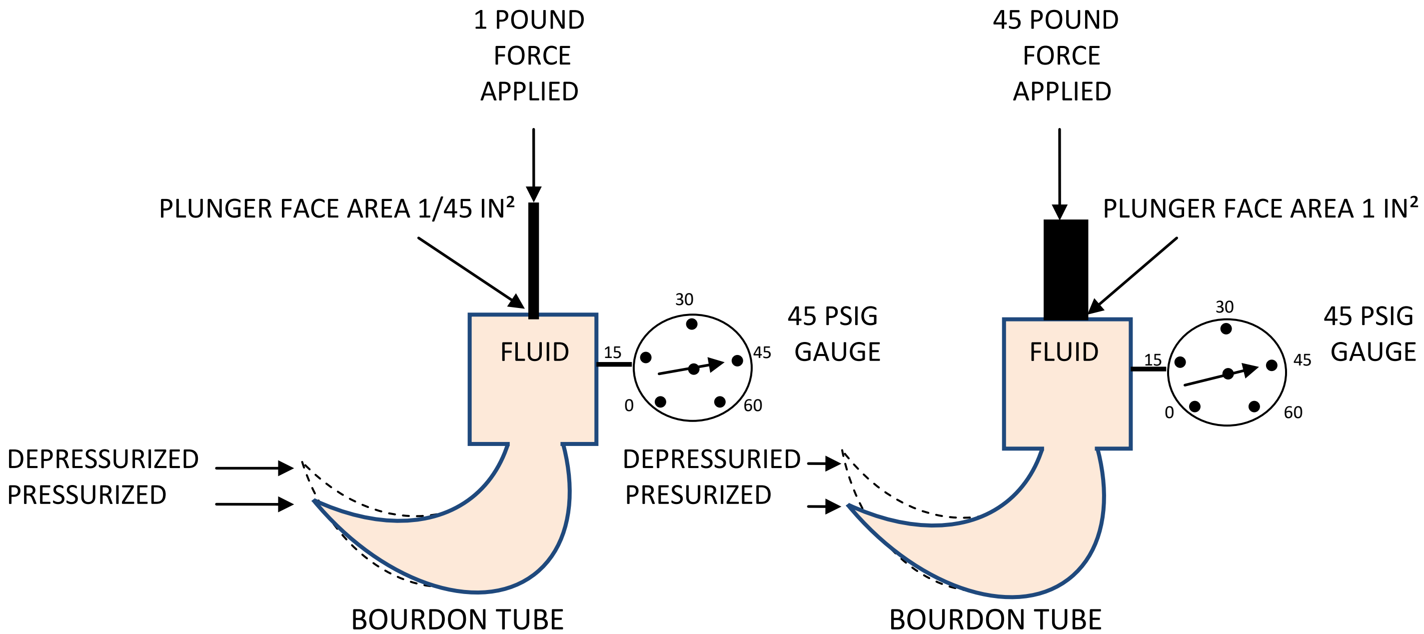
PASCAL’S PRINCIPLE AS IT APPLIES TO BOURDON TUBE PERFORMANCE

PASCAL’S PRINCIPLE

"*A change in pressure applied to an enclosed fluid is transmitted undiminished to all portions of the fluid and to the walls of its container.*"

IF NO VOLUME CHANGES ON PRESSURIZATION

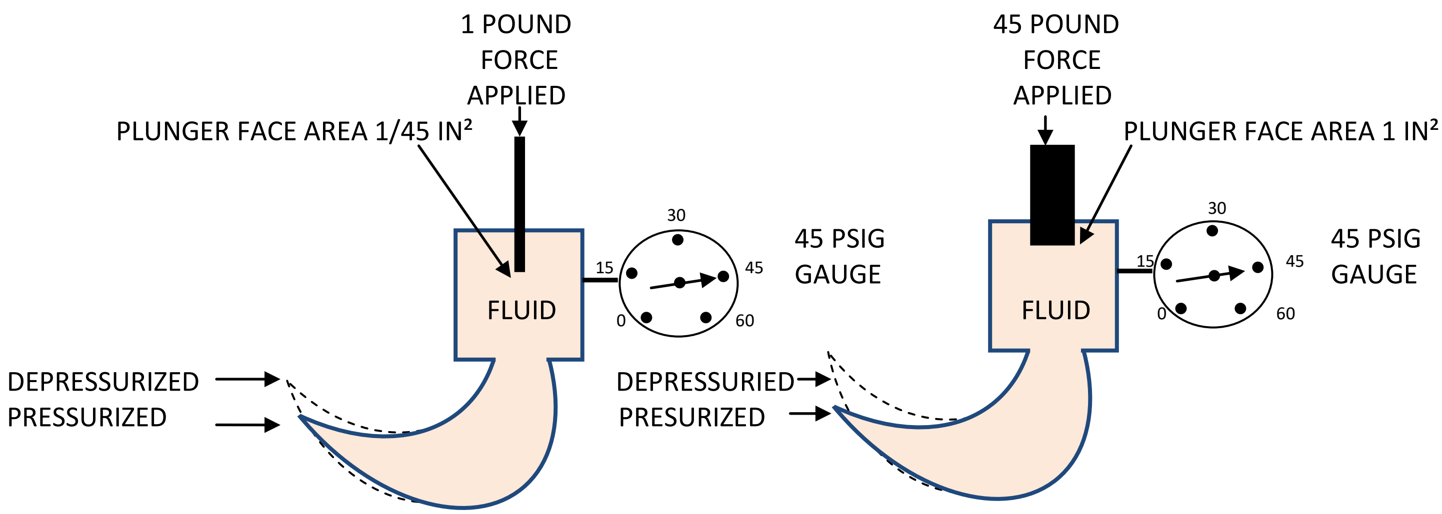
Assuming the volume of a bourdon tube does not change on pressurization, as per opinion of industry experts and Pascal’s Principle is valid, the illustrated bourdon tubes can be pressurized to 45 PSIG by various combinations of force and fluid surface area where the force is applied. Two examples are illustrated.



IF VOLUME CHANGES ON PRESSURIZATION

Assuming the volume of a bourdon tube does change on pressurization, contrary to opinion of industry experts and Pascal’s Principle is valid, the illustrated bourdon tubes can be pressurized to 45 PSIG by various combinations of force and fluid surface area where the force is applied. Two examples are illustrated.

This is valid if the displaced fluid volume, via the plunger, is greater than the volume change in the fluid when altering from depressurized to pressurized.



BOURDON TUBE FORCE VARIATION AND DISPLACEMENT VARIATION

1) Page 7 presents the experiment determining the bourdon tube tip force variation at different internal pressures.

2) Page 8 presents the experiment determining the bourdon tube tip displacement at various internal pressures.

FORCE VARIATION AT DIFFERENT PRESSURES IN A BOURDON TUBE

“A”

FORCE = 9 OZ.

PRESSURE = 20 PSIG

BOURDON TUBE

FORCE = 1 POUND = 16 OZ.

"B"

PRESSURE = 45 PSIG

“C”

FORCE = 1 POUND & 15 OZ. = 31

OZ. PRESSURE = 60 PSIG

NOTE:

The 31 OZ. force of “C” can be attained by increasing the fluid supply pressure, as illustrated, to 60 PSIG, or if Pascal’s Law is true, by isolating the bourdon tube from the pressure source and applying the one pound (16 OZ.) force of “B” to 1/60th IN^2 of the incompressible fluid surface of “C”, causing a 60 PSIG the pressure reading.

If **W**ork = **F**orce X **D**istance (**W=FD**) and (“**D**” FOR “B”) = (“**D**” FOR “C”); then **W** ”B” = 16 units and **W** ”C” = 31 units; however **W** ”B” can generate **W** ”C”, as explained; therefore, “B” can attain 193.75% (31 OZ/16 OZ) more **W** if its force is applied to the fluid surface of the incompressible fluid surface of “C”. Conclusion: Lesser $\mathbf{W}_{input}$ can produce greater $\mathbf{W}_{\mathbf{output}}$.

DISPLACEMENT AND FORCE EXERTED OF BOURDON TUBE AT VARIOUS PRESSURES

START

PRESSURE GAUGE

DIGITAL CALIPER

BOURDON TUBE

21 PSIG

1.6 mm DRIVE

(FORCE = 9 OZ)

45 PSIG

3.23 mm DRIVE

(FORCE = 16 OZ)

59 PSIG

4.56 mm DRIVE

(FORCE = 31 OZ)

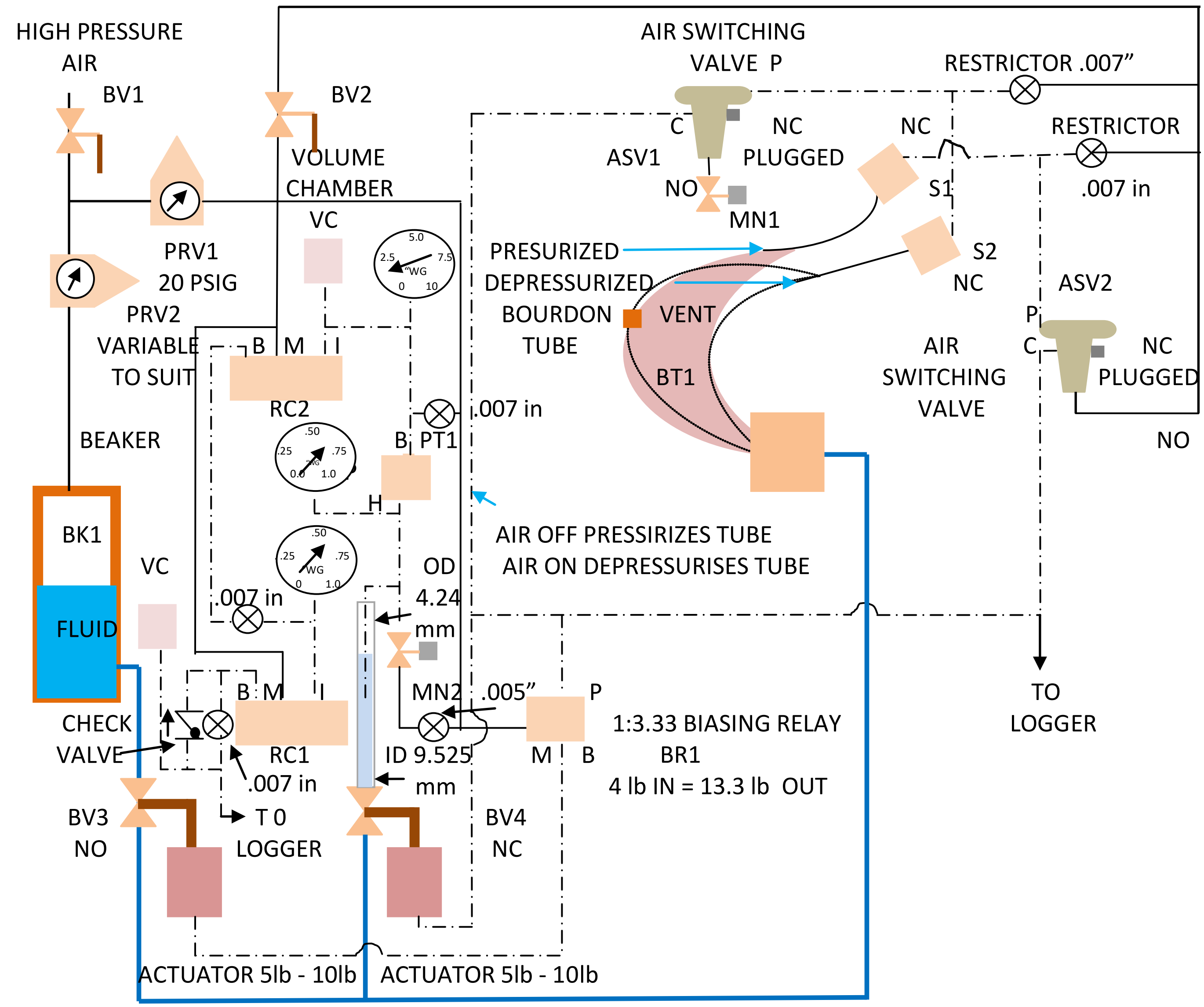
VOLUME RELATIONSHIP EXPERIMENT

The presentation on page 10 illustrates the experiment to assess if the volume changes on pressurization of a bourdon tube.

The photo on page 11 presents the physical arrangement of the test.

More pneumatic components and a different valve arrangement were required to cause the system to reciprocate as require for the test.

Venting the air from the system has presented a serious challenge.



-1- No air pressure; therefore, bourdon tube (BT1) is relaxed, hitting sensor (S2).

-2- Open ball valve (BV1) pressurizing beaker (B1). Ball valve (BV3) allows fluid pressure to bourdon tube (BT1), flexing BT1 to hit sensor (S1). BT1, via S1, causes air switching valve (ASV2) to position NO to C.

-3- Open ball valve (BV2), allowing pressure to build via S1 to ASV1's pilot, closing ASV1's NO port.

-4-BT1 opens S2, causing pressure from PRV1 to go through ASV2 to switch fluid BV3 and BV4 and to the logger. BV3 closes BT1 to beaker (BK1) and opens BT1 the 9.525 mm ID clear tube VIA BV4, depressurizing BT1. Biasing relay BR1 coordinates BV3 and BV4 so only one can be open at a time and there is two pound dead span where both are closed during switching.

-5- BT1 relaxes and returns to its depressurized position.

-6- If a volume increase is experienced by BT1 on pressurization, fluid will flow to the 9.525 mm ID tube on depressurization.

-7- On depressurization BT1 will return to hit S1 and close S2. ASV2's NO port will close. S1 will open opening ASV1's NO port to C.

-8- Microneedle valve (MN1) will determine the rate of cycles as BV3 and BV4 change their porting on switching.

-9- This creates a reciprocating cycle. Note the "WG level change of the 9.525 ID tube after a few cycles.

-10- If it appears that no level change is experienced, continue experiment. (If level increases; calculate % change.)

-11- Adjust MN1 to establish a fixed number of cycles per minute.

-11- The change in fluid in the 9.525 mm ID tube is sensed by pressure transmitter (PT1) via the 4.24 OD tube with air slowly bubbled into it via MN2. Minimum bubbles maintained while keeping the 4.24 OD tube the waterless.

-12- Program trend reader to read cycles over prolonged period of time and calculate level change for 1,000 cycles.

-13- The open area to atmosphere of fluid in the 9.525 ID tube with 4.24 mm tube inserted is .57107 cm^2.

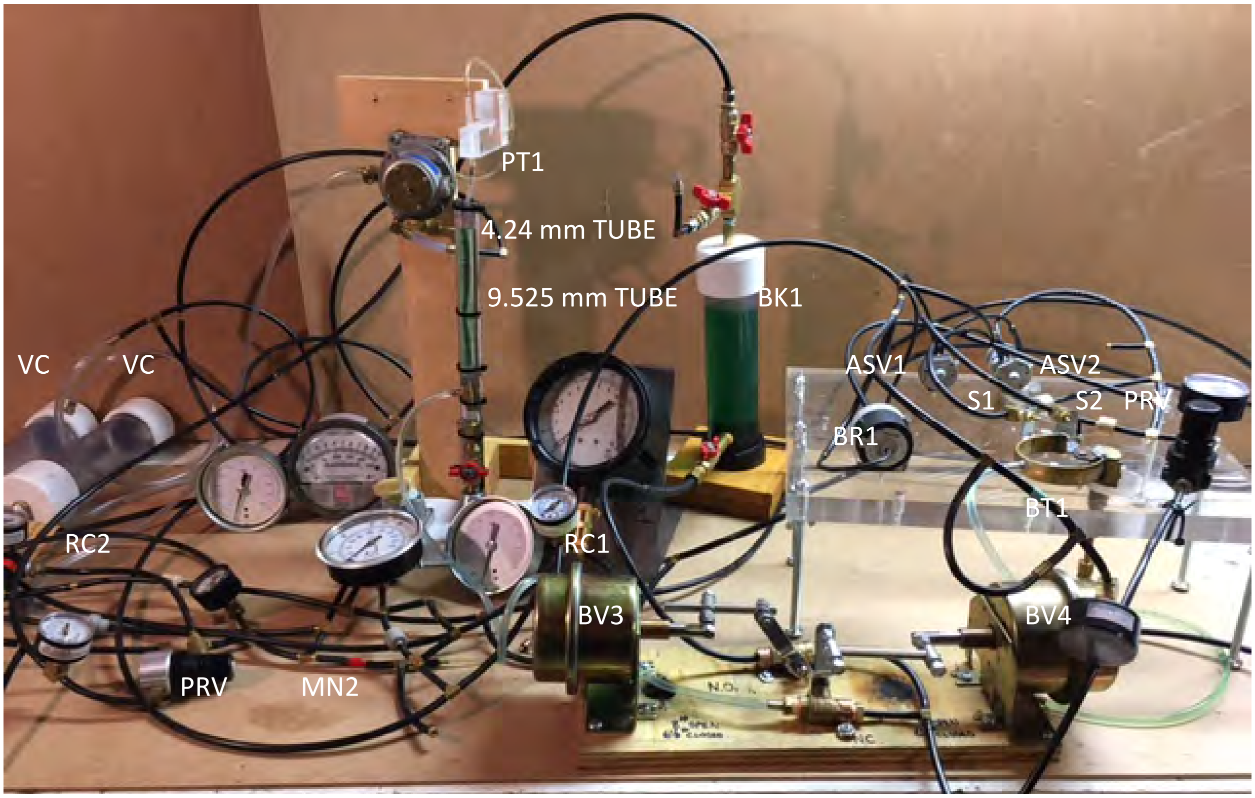
-14- Testing indicates that one drop of water alters the level in the 9.525 mm ID tube by .02" WG.

-15- .02" WG change equals a volume change of about .029 cm^3 (.029 gram), producing a 3 PSIG output change from RC1, which has an input range of 1.0" WG.

-16- On the Trend reader each PSIG represents 1.49 volts which can be subdivided into thousands of a volt.

-17- The test equipment is able to record volume changes of about .000001 cm^3 (.000001 gram of pure water).

PHYSICAL TEST MODEL OF CIRCUIT PRESENTED ON PAGE TEN



WORK INPUT INCREASED TO WORK OUTPUT

-Page 13 presents the experiment regarding increase of work output over work input.

-Page 14 is a page from USA patent 7467517 commenting on a volume increase compensation method.

If the volume does increase on pressurization, the entering shaft, exerting the force on the second tube can mitigate the volume change impact if the volume of the shaft displacement is greater than the volume change of the bourdon.

POTENTIAL WORK INCREASE APPLYING PASCAL'S PRINCIPLE USING BOURDON TUBES

Using the experimental data presented on pages seven and eight, the relationship illustrated below of two bourdon tubes presents the case of $Work_{output}$ > $Work_{input}$.
(.3492 in-lb output work potential generated by .127 in-lb input work potential)

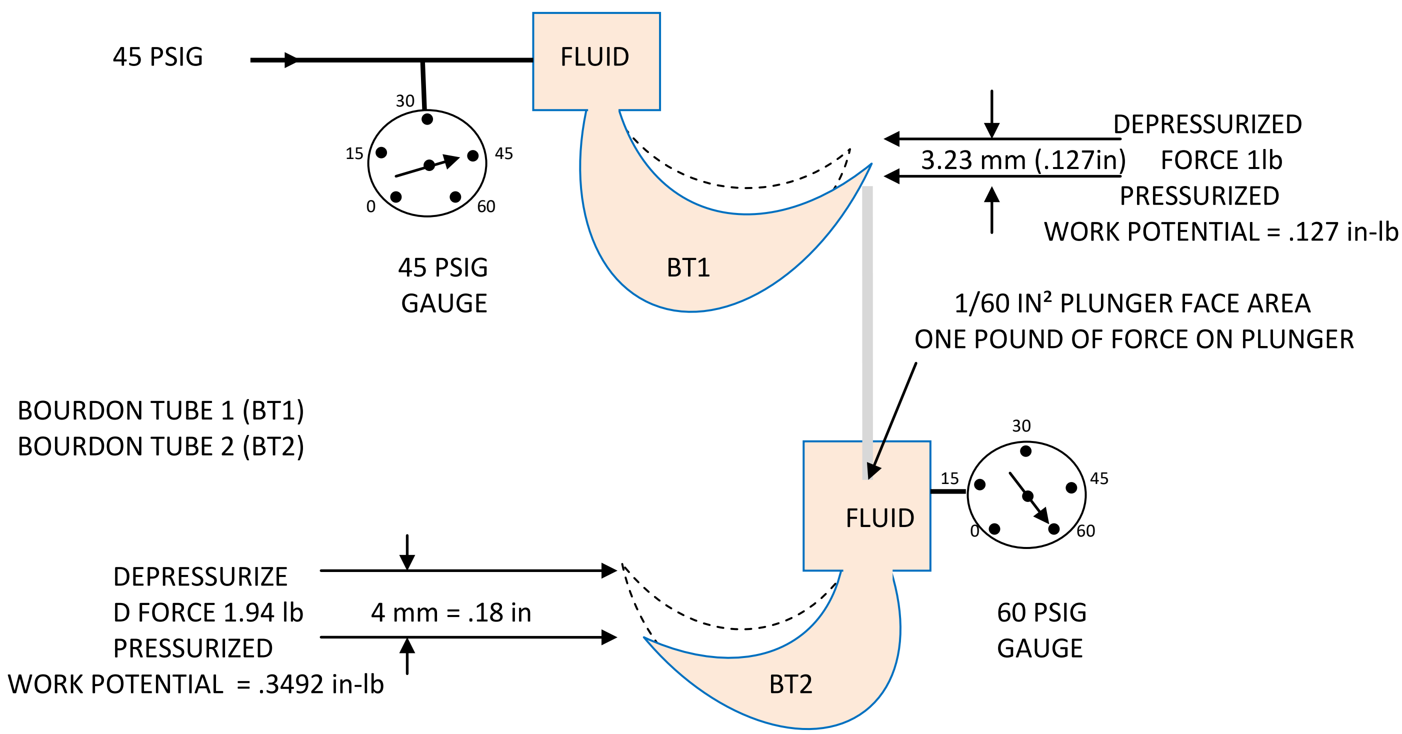
This conclusion is based on:

1) Pascal's Principle being valid and either
2) The volume does not change in bourdon tubes when being pressurized or
3) The volume displaced by the plunger into bourdon tube (BT2) is greater than the volume change in BT2 caused by pressurization.

NOTE: Of several R & D departments contacted of manufacturers using bourdon tubes, most stated they had no data on if the volume in a bourdon tube changes on pressurization. Two manufacturers stated that they believe the volume does not change.

Extensive research concludes that data on bourdon tube volume change is likely unavailable in the industry.

A volume change compensating feature in a current patent may compensate for volume change while maintaining the fluidic advancement presented at the top of this page.



CONCLUSION: .3492 in-lb > .127 in-lb; therefore W_{output} > W_{input}

In one aspect or embodiment, the invention uses a solenoid to apply a force to a fluid in communication with a near constant volume fluidic linkage. A voltage applied to the solenoid pressurizes the fluid causing the constant volume fluidic linkage to displace. In this way, a transducer is created that converts voltage into a displacement. To create a motor, the displacement is used to stop the application of the voltage to the solenoid allowing the constant volume fluidic linkage to return to an initial state. The return to the initial state then triggers the re-application of the voltage. In this way, the voltage source is used to create a reciprocating motion. Because the displacement is produced through a constant volume fluidic linkage, the solenoid travels only through a minimal, if any, stroke. Because very little, if any, change in volume is required, the fluidic piston may be replaced with another linkage, such as one with a diaphragm wall that does not require moving seals. Alternately, the size of any moving seals may be minimized. Among other advantages, the transducer or linkage may avoid one or more of the inefficiency, mechanical complexity and wear related problems associated with long-stroke solenoids or conventional stroking fluid pistons. Although a voltage source is used as the input energy source, analogous transducers or motors may use fluid pressure sources, such as compressed air or a liquid pressure, as the input energy either to replace the solenoid as the drive for the plunger or to pressurize the inside of the constant volume fluid linkage directly. Liquids, particularly minimally compressive liquids, are preferred for use in all fluid filled parts of the transducer or motor to reduce volume changes due to compression of the fluid. A volume compensating circuit or device may be used to reduce or eliminate the effects of any change in the volume contained in the transducer or motor or the effects of compression of the contained fluid.

This summary is intended to introduce the reader to the invention but not to define or limit the invention. Other aspects of the invention may reside in other combinations or sub-combinations of elements or steps described above or in other parts of this patent.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described with reference to the following figure(s).

FIG. 1 is a schematic representation of a motor having a transducer with a constant volume fluidic linkage.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows a motor 10 having a transducer 12 which converts electrical energy or pressure into a reciprocating energy. The transducer 12 has a solenoid 14 that applies a force to a plunger 16 when a voltage is applied to the solenoid 14. The plunger 16 may or may not move in response to the applied force. The plunger 16 bears on a fluid 18 in a container 20. For example, the plunger 16 may protrude into the container 20 through a seal 22 which may be an O-ring, U-cup or other type of seal. The seal 22 permits movement of the plunger 16 while maintaining a seal between the plunger 16 and container 20. Thus, if the contained volume in the motor 10 increases by a small amount or if the fluid compresses by a small amount when the fluid is pressurized, movement of the plunger 16 into the container 20 can compensate for these effects by decreasing the contained volume of the motor 10. Alternately, the plunger 16 may bear on the outside of a diaphragm wall of the container 20 or the plunger 16 and container 20 may be a conventional fluidic piston.

The container 20 is connected through fitting 24 to the base 26 of a Bourdon tube 28. As discussed above, other sorts of (near) constant volume fluid linkages may be used in place of the Bourdon tube 28. The base 26 allows the Bourdon tube 28 to be mounted to a structure and also provides a path for fluid communication between the fitting 24 and first end 30 of the Bourdon tube 28. A second end 32 of the Bourdon tube 28 has a hook 34 for attaching the motor 10 to a driven device, for example a crankshaft. A vent valve 36 allows air to be bled from the Bourdon tube 28 so that it is filled entirely with the fluid 18. The fluid 18 is preferably a minimally compressive liquid such as water, mercury or glycerine.

When the fluid 18 is at an initial pressure, the second end 32 of the Bourdon tube 28 rests in a first position 40. When a voltage, resulting in a current, is applied to the solenoid 14, a force is applied to the plunger 16 which pressurizes the fluid 18. This causes the second end 32 of the Bourdon tube 28 to move to a second position 42. When the voltage is removed, the second end 32 of the Bourdon tube 28 returns to the first position 40. An electrical circuit 50 connects a

OPINIONS OF INDUSTRY EXPERTS

Pages 16, 17 and 18 are from an Engineering Master's Thesis prepared by Cynthia Conway. After extensive research no data could be found on if the volume of a bourdon tube changed on pressurization.

We also did extensive research attempting to determine if the volume of a bourdon tube changed on pressurization. The last attempt questioned the R & D divisions of gauge manufacturers who work with bourdon tubes. Of the many approached, four stated they have no data on the matter and two stated that the volume does not change.

The net result left us concluding that it is an unknown fact.

If it does change, the volume compensation characteristic will still allow the proof of $W_{in} < W_{out}$, if the volume change is less than the volume displacement of the entering shaft forced by the first bourdon tube illustrated on page 13.

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THESIS

ANALYTICAL ANALYSIS OF TIP TRAVEL IN A BOURDON TUBE

by

Cynthia D. Conway

December, 1995

Thesis Advisor: R. Mukherjee

Approved for public release; distribution is unlimited.

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ANALYTICAL ANALYSIS OF TIP TRAVEL IN A BOURDON TUBE

Cynthia D. Conway
Lieutenant, United States Navy
B.S., Clemson University, 1990

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
December 1995

Author: [redacted]

Cynthia D. Conway

Approved by: [redacted]

Ranjan Mukherjee, Thesis Advisor

[redacted]

Matthew D. Kelleher, Chairman
Department of Mechanical Engineering

C. PROBLEM FORMULATION

1. Geometric Relationships

Assuming that the volume of the Bourdon changes as deformation occurs, the change in the semi-major axis *da* is expressed as a function of the change in the semi-minor axis *db* by the equation

$$da = \frac{a \cdot b \cdot (E - K)}{E \cdot a^2 - K \cdot b^2} \cdot db \qquad 2.8$$

The derivation of equation 2.8 is presented in Appendix A. For a unit length, the volume of the Bourdon is defined by the equation

$$V = \pi \cdot a \cdot b \qquad 2.9$$

The change in volume then becomes

$$dV = \pi\,(a \cdot db + b \cdot da) \qquad 2.10$$

or

$$dV = \pi a \left[\frac{\left(a^2 + b^2\right) \cdot E - 2Kb^2}{Ea^2 - Kb^2} \right] \cdot db \qquad 2.11$$

by making the substitution for *da* in equation 2.10.

Bourdon tip travel is a function of the sectional deformation that occurs as a result of pressurization. For an applied internal pressure, a curved circular tube will not

SUMMARY

If Pascal’s Principle is valid and the industry experts' opinion that no volume change occurs during pressurization of a bourdon tube is true, proof that $W_{in} < W_{out}$ can be achieved.

We believe that, although indicating the Laws of Thermodynamics require reassessment, the actual extra work potential available is likely minor; however, open doors to significant gains.

The purpose of this exercise is to attempt breaking down the psychological barrier causing uncontested acceptance of the Laws of Thermodynamics.

I once met a man who claimed to have had the position in both the Federal and Provincial governments assessing such inventions that challenged the status quo. He stated “For the life of me, I could not see why some of those inventions would not work, but we had to reject them anyway because the government could not be seen as supporting such inventions.”

We believe this was dishonest and unscientific on the Government's part and retarding to the advancement of real science.

We believe it will require only one invention breaking through the unsupported faith in the Laws of Thermodynamics to open the doors to many rejected inventions that will help mankind in addressing the Climate Change threat we all face.

The patented invention linked in this report (page 2) to the Diamond-shaped fluid powered linkage, system and engine has been assessed by many scientist/engineers. All have agreed with the fact that the new style actuator is more efficient than a convention piston. The basic principle of more efficiency was patented in 1874 by Mr. Reilley. This invention has the potential to provide pollution-free work addressing the Greenhouse Gas issue associated with Climate Change.

Progress has been blocked by scientist/engineers/professors who have not provided any supporting explanation of their rejection of the detailed drawings and physical demonstrations, other than quoting the Laws of Thermodynamics.

Please send questions or comments.

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