Collected articles from the 1st International Scientific and Practical Conference "Tore Technologies". June 30 – July 2, 2004. Irkutsk Technical University, plenary report, pages 22-48. Translation from Russian.

Tore Technologies as the Basis for Elastic Engineering.

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Up-to-date Electronic, Information and Energy technologies have reached the physical limits of their development because:

- Further decrease of the components size is limited by one atomic layer;
- The speed of electronic stream inside these components cannot exceed light speed;
- The development of primitive matrix architecture increases dimensions and energy consumption;
- The use of hydrocarbon and atomic fuel as the source of energy has marked the beginning of Life's disappearance in the Earth and eventually its death;
- The conversion of the energy of the Sun, atmosphere, hydrosphere and Space has stopped at two percent of the total energy consumed by mankind because the mankind does not have adequate knowledge how effectively convert this inexhaustible energy.

However, the biggest paradox lies in the fact that today's Electronic, Information and Energy technologies "service" the Mechanics, which appeared thousands years ago (!) and is still being "polished" thus increasing (killing) energy resources of our planet in geometric progression.

Probably *Tore Technologies* (*TORTECH*®) and *Elastic Engineering* (*ELASTONEERING*®) based on *Toroidal motion,* the steadiest motion in the Nature, might become new trends in natural and technical sciences and consequently the "key" to the problem.
Many natural structures, *natural elastic machines and mechanisms,* are based on toroidal motion.
The source and generator of toroidal motion is a thin, sealed elastic/toroidal shell filled out with fluid medium at overpressure (gas) or normal pressure (liquid) – *elastic toroid.*
Natural elastic toroid is capable of generating (building) and integrating mechanical, electronic, information and energy components into one intellectual elastic system formed in the shell "material" and fluid / working medium within this shell.

This system includes sensors and actuators, information and energy pipelines, data processing centers, generators, energy converters etc.
Coordinated actions of mechanical and electronic systems formed as one physical structure allow elastic machines and mechanisms effectively maintain their life, i.e. to

perform the motion (work) with minimum energy consumption and energy interchange in the environment.
The examples of natural machines and mechanisms are:

- Fields of forces [1];
- «Hadley cell» – systems of atmospheric motion on Mars and Earth [2];
- Sea and Ocean currents motion on Earth [3];
- Hill twister [4], Benar cells and Couette flows [5];
- Peristaltic process and invertebrates locomotion systems [6];
- «Bimodel Makarov cell» [7];
- Tornados [8];
- Info and energy vortical erythrocyte (blood) packages of [9], comets [10], ball lightning [11];
- Galaxy [12];
- Kelvin vortex atoms (ovals) [13];
- Karman vortex trail [14];
- Helmholtz vortex rings [15] etc.

In Nature there are living organisms living in fluid medium, flagellates [16] (*Mastigoohora),* zoospore, spermatozoa etc. who use their flagellum for locomotion (like motor); the flagellum drags along the entire cell. When these organisms move, they create toroidal water motion.

The author of this paper used amazing similarity of *natural and technical* elastic (tore) machines and mechanisms to describe the peculiarities of elastic mechanics**.**

The knowledge obtained by the author during the development of technical elastic machines and mechanisms allowed him better understand many unknown natural phenomena, and vice versa, the knowledge accumulated by sciences about *natural* elastic machines and mechanisms helped him in the development of *technical* machines and mechanisms.

When subjected to internal or / and external forces the natural or technical elastic toroids generate the toroidal motion of several types (Fig.1) including (see the details in [107 - 110]) the following:

- The elastic toroid progressively moves forward by rolling along long axis and *turning outside (eversion) / pulling in* [17] or, on the contrary, *enveloping/ screwing* with respect to the *anchoring* belt of external peripheral or central body; simultaneously its central part (comet, Galaxy etc.) and peripheral parts rotate (vortex motion) along the same axis (Fig. 1-1 and 2). There is also the motion when the central or peripheral parts do not rotate along the longitudinal axis. In this case the toroidal motion is not so steady and may cause elastic toroid's break ("smoke ring of a smoker"). The so - called "black hole" is the rotating central part ("core") of the Galaxy – a gigantic natural elastic toroid;
- There is no progressive movement of elastic toroid along long axis, this means that elastic toroid is turning outside / enveloping without moving forward

(skidding); simultaneously the central and peripheral parts of elastic toroid are rotating (vortex motion) along the same axis (Fig. 1-3). There is no anchoring belt (external peripheral body) and progressive movement's speed is equal to zero ("hanging" ball lightning). There is also the movement when the central and peripheral parts do not rotate. In this case the toroidal motion is not steady and elastic toroid may subsequently fall out;

- The elastic toroid (tore) progressively moves along medial line (circle, oval) - *toroid's strings* and simultaneously rotates along the same line –"vortex motion" (currents of the World Ocean), (Fig. 1-4). When elastic toroid is not rotating along the same line (toroid's string) it may be damaged;
- The central part rotates along longitudinal curve (axis) of elastic toroid, but there is neither eversion /enveloping nor progressive motion. The elastic toroid does not have periphery (spout in the atmosphere or whirlwind in deep water) (Fig. 1-5);
- Turning inside out when tore is transformed into toroid (Fig. 4);
- The combination of above types.

Thus, the toroidal motion is the basic (superior, key, main, generating) type of motion, not a separate sub-type like in [18].

It includes or generates:

- Progressive, linear motion – laminar flow and / or longitudinal, oscillatory motion and / or;
- Rotary motion around and / or along longitudinal axis and / or ;
- Diffusion motion ensuring propagation of density and / or motion quantity (impulse) and / or energy and / or information.

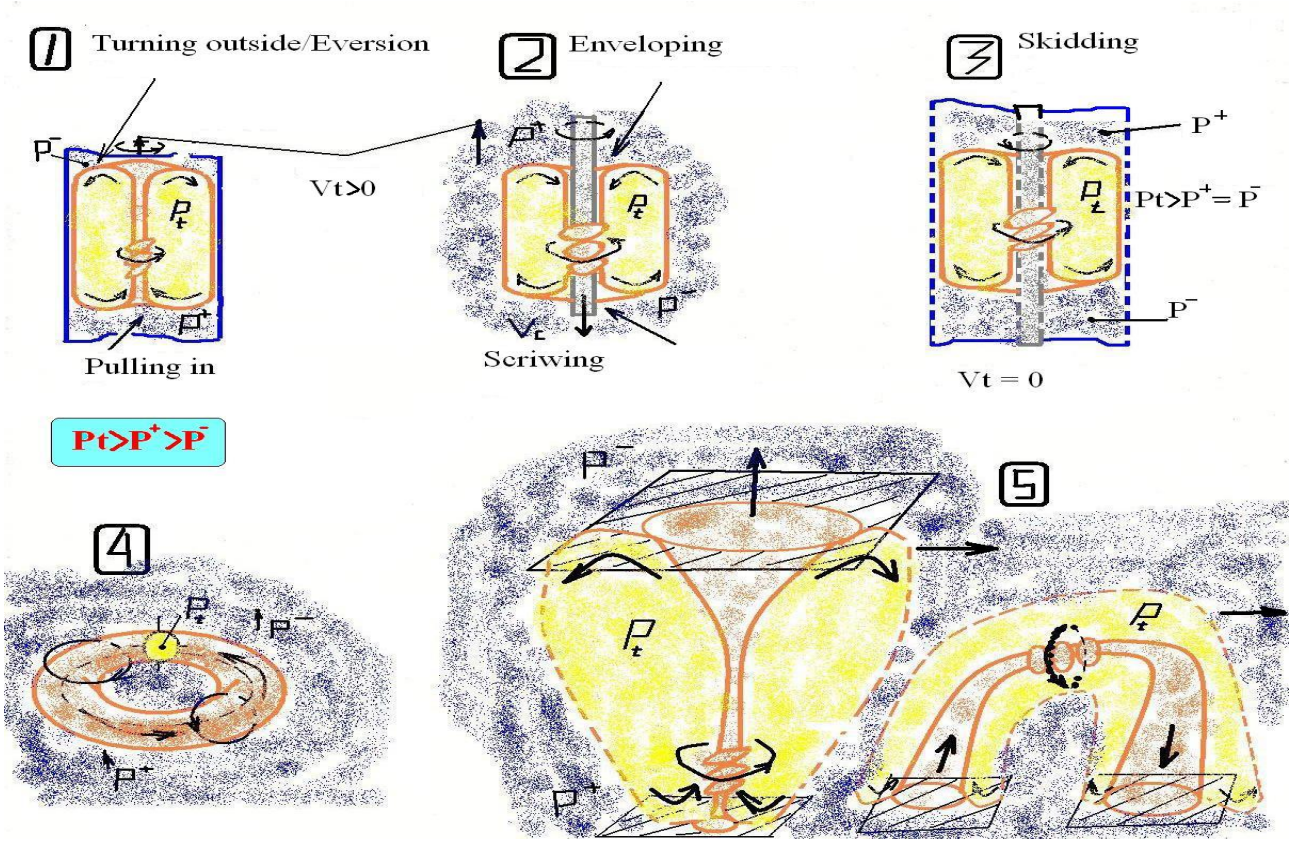

Fig. 1 Types of the toroidal motion

Specific Features of Elastic Engineering

1) The mechanical and electronic systems of a machine or mechanism are formed as one physical structure performing mutually coordinated functions.

2) Energy and movement conversion is a single-link mechanism capable of performing the same functions as multi-link mechanism in conventional, rigid mechanics.

3) *Tore technologies* – are machines and mechanisms whose mechanics is based on toroidal motion. The key element, generator and carrier of this motion are *elastic toroids* having at least five degrees of freedom.

This elastic system under effect of external and / or internal forces is continuously searching equip-stress condition; this is the main function of tore within tore (elastic) machine or mechanism.

So, under the effect of external and/or internal forces elastic toroid has the following functional features, it:

- Moves by turning outside (eversion) or enveloping over rigid, elastic or any other support surface covering and enveloping its deformed parts and foreign inclusions; when in movement, self-packs in a closed surface covering its periphery (“finds itself”);
- Provides big controllable contact area and small specific pressure on support surface at low fluid medium pressure in the shell;
- Produces pulling forces and impact effect;

- Converts various types of motion, for example progressive motion into rotary one and vice versa;
- Enveloping an object grips, holds and/or handles it inside at controlled wringing force ("soft gripping");
- Turning outside ejects embedded object at a controlled velocity;
- Turning outside and / or enveloping changes its steady state;
- In a "break point" (where the central part of elastic toroid adjoins its periphery) provides a hinged swing of minimum one free end;
- During the eversion the progressive motion of the central body is twice as large as toroid's speed relative to its periphery, whereas during enveloping the progressive speed of the periphery is twice as large as toroid's speed relative to its central part;
- Moves in transverse direction by rolling.

The functional capabilities of a machine or mechanism with elastic toroid within it are doubled because there are two working surfaces on the outside part of elastic toroid: *central part* and *periphery* gradually passing from one to another thus forming *two - side close surface* [19].

In order to realize potential properties elastic toroids may have various shapes (Fig.2), they are cinematically connected to such design elements as *central* and/ or *external* and/ or *internal peripheral bodies* of various shapes (Fig. 3) made of different materials.

Thus, each working surface of elastic toroid performs its specific function:
- *Elastic toroid's periphery* is characterized by local positive gauss crookedness and gradually comes to its *central part* that possesses local negative gauss crookedness;
- The boundary surface between periphery and the central part of elastic toroid possesses zero gauss crookedness located at its flank – bend curve or the gauss crookedness change of sign line;
- If the anchoring belt (plane, line or point) of elastic toroid is located at its periphery, then under effect of external and /or internal forces it is *turning outside* and simultaneously advancing in longitudinal direction relative to the anchoring belt to the area of less pressure;
- If the anchoring belt of elastic toroid is located in its central part, then under effect of external and /or internal forces it is *enveloping* and advances relative to the anchoring belt to the area of larger pressure;
- If the anchoring belt of elastic toroid is located on the boundary of its periphery and central part (at its flank) a *breaking* (friction grip) occurs and the eversion / enveloping processes are ceased and consequently the forward toroidal motion is also stopped;
- The pressure inside elastic toroid must be always greater than the external pressure, otherwise under the effect of larger external pressure the elastic toroid will be squeezed and lose its operational integrity.

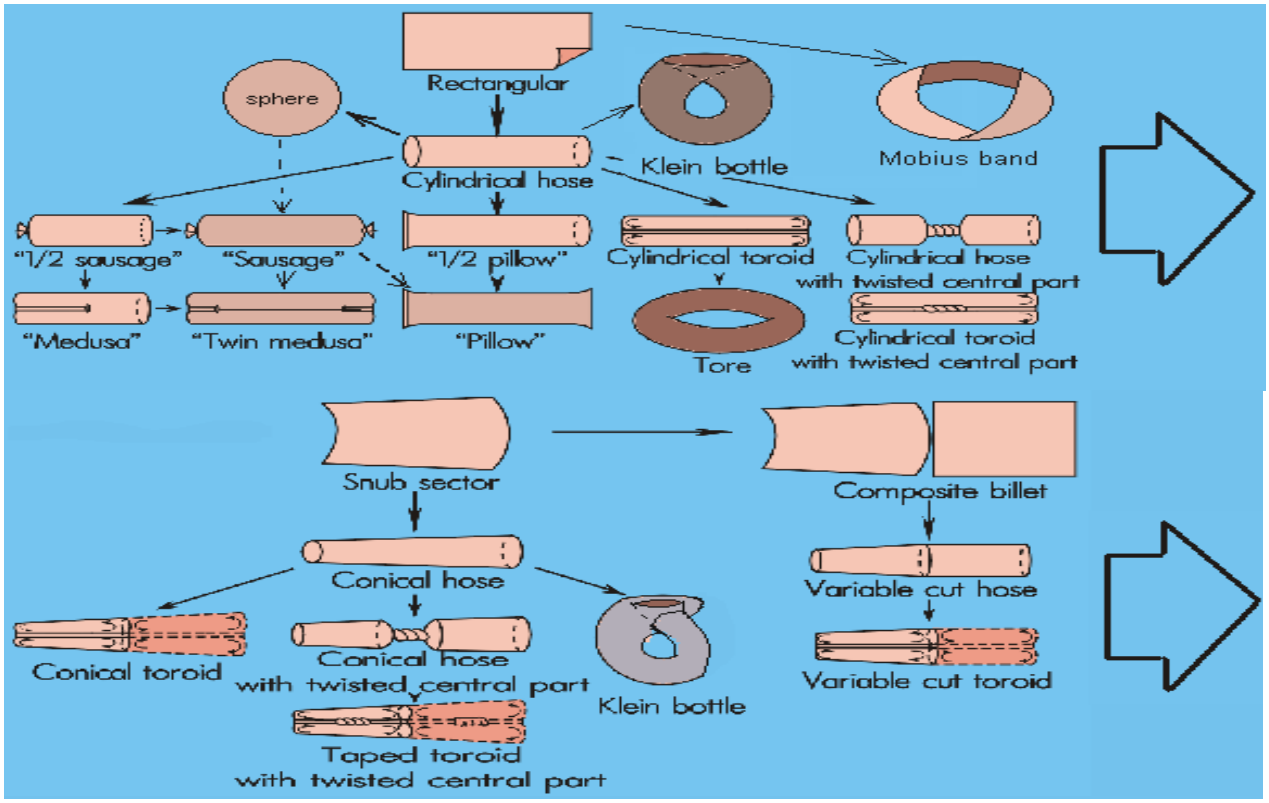

Fig. 2. Classification of elastic/soft single - and- double-sided surfaces or cutting & assembly plan of single and multi component elastic toroid shells

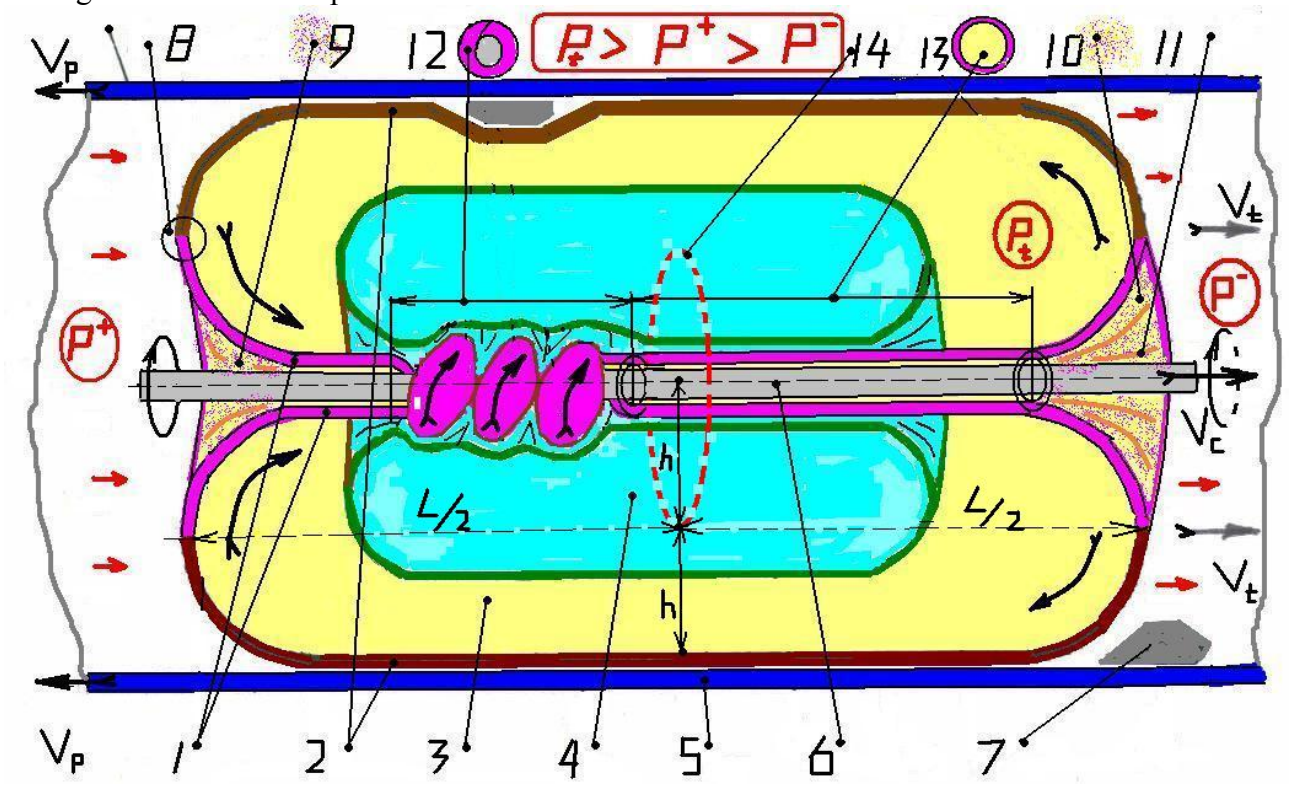

Fig. 3. Complex Toroidal Device

1 - 3 - Elastic Toroidal Shell with Working/Fluid Medium – Elastic toroid: 1 – Central part (Pink), 2 - Peripheral part (Brown), 3 – Working medium (P_t).

4 - Internal peripheral body, 5 - External peripheral body, 6 - Central body, 7 – Obstacle, 8 - Curved line (oval) of Elastic Toroid's Inflection, 9 - Elastic Toroid's Master End Face with Funnel$^+$-Predictor (P^+), 10 - Elastic Toroid's Driven End Face with Funnel$^-$-Corrector (P^-), 11 – Folds, 12 –

"Running" Curling, Twisting/Winding (fixed/nonchanging quantity), 13 – Cylindrical "Well", 14 – Elastic Toroid/Tore's Middle Line (String Tension).

It should be kept in mind that (Fig. 4):

- Internal surface – the cavity of elastic toroid's shell is always contacting the fluid/ working medium being also a close two side surface;
- "Eversion" and "turning inside out" are different processes;
- When elastic tore turns inside out the elastic toroid is formed [20, 40], whose length is half of the tore's medial line length (circle, oval etc.) and the tore diameter is equal to tore forming circumference (ring part);
- Elastic toroid and tore made of the hose whose diameter does not change are cylindrical elastic toroid/tore, whereas elastic toroid and tore made of the hose whose diameter increases or decreases following certain rules are conical elastic toroid/tore. There may be the combinations thereof;
- Elastic tore and toroid are dynamic tore and toroid in a continuous movement – toroidal motion;
- Static tore (wheel chamber, ring – buoy etc.) and consequently outside turned toroid are two-side, close elastic/soft/flexible/rigid surfaces that do not perform any toroidal motion and therefore have nothing to do with tore technologies and elastic engineering.

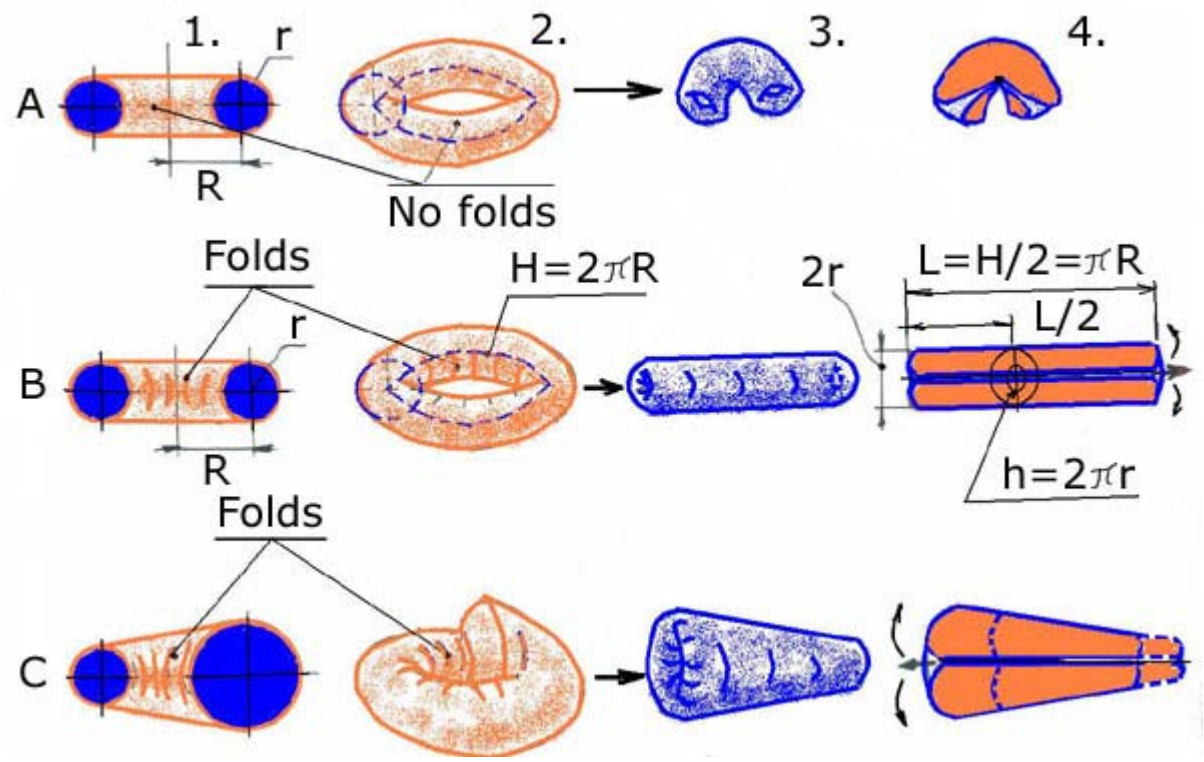

Fig. 4. Topological and practical transformation of elastic tore into elastic toroid and vice versa (turning inside out) as well as tore and toroid's elements: H – tore medial line, tore's string, h – toroid's medial line, toroid's string, L – toroid's length.
A. Static, not dynamic, tore (1 and 2) and the figure formed as the result of its turning inside out (3 and 4) cannot create toroidal motion.
B. Dynamic elastic tore (1 and 2) and cylindrical elastic toroid formed by the eversion cannot produce toroidal motion.

C. Dynamic elastic tore with continuously increasing diameter of a formative circle (1 and 2) and conical elastic toroid formed by the eversion; the (1) can produce toroidal motion approximately equal to the length of the (2) in the direction from less diameter to larger diameter.

4) Electronic and information system of the machine and mechanism is formed directly in the material structure of elastic toroid's shell creating an intellectual elastic composite material, living layer («smart layer») and / or fluid medium with controlled rheology - intellectual fluid / working medium within the shell and / or in the design elements cinematically connected to the shell.

Therefore, there appears new trend in the design of devices, mechanisms and machines in radio electronics, radio engineering and machine building – *macrominiaturization* (*MACROMINIATURIZATION*™) as the basis of *elastic electronics.*

At the same time, the following basic properties of elastic toroid shell material should be retained:

- *Flexibility*, i.e. obtainable flexural strain up to the radius approaching the material thickness;
- *Elasticity*, i.e. obtainable 200% tensile deformation;
- *Softness* …

Machines and mechanisms with elastic toroids whose shell is made of intellectual composite material and filled with intellectual fluid / working medium are called *elastic.*

The devices generating fluid medium at overpressure can be used as the drive (energy source), these are pumps, including vacuum ones, compressors, gas generators etc. with various characteristics as well as any means and devices violating quasistatic process or equilibrium state (mechanical, thermodynamic, chemical etc.) of the system.

Today there are numerous solutions how to combine electronic and mechanical systems in one machine.

These are: soft electric heating units; "intellectual" clothes ("underwear net"); rubber-mercury sensors used for measuring load parameters in air casing; ribbon power and information cables; goods made of conductive rubber; elastic thermal- conduction isolators; simple devices used to control the operation of shell structures, embedded into shell material (pressure gage, valves, end switches, conductive overalls to neutralize electrical static current); scotch tape made of flaky polymer materials used for storing holographic data; radio and short wave frequency antenna irradiators; semiconductor displays made of hybrid, organic and non-organic materials; "rag" solar batteries – a shirt of synthetic fiber which under the effect of light generates electrical energy etc.

These technical solutions allow integration of independent electronic and / or mechanical systems in one machine or mechanism, saving technological and

domestic space, improving consumer properties etc. and have nothing to do with elastic engineering.

5) Elastic machine or mechanism is capable of performing self-diagnosis and can regenerate.

6) The fundamental feature of elastic mechanics is the possibility of obtaining absolutely new integrated mechanical & electronic systems, for example new soft elastic radio elements, energy sources and converters, motors and propulsors, robots, spare parts for men and animals etc.

Advantages of Elastic Machines and Mechanisms:

- It is possible to get new step less forms of motion peculiar to fluid medium, shell and design elements cinematically connected to the shell, such as take-off, landing, flow, displacement in unequal direction, enveloping, eversion, fluctuation, undulatory movement, fluctuation along and across the rotation axis, folding, telescopic packing etc.;
- Elastic toroid's geometrics are changing from parts of millimeters to tens or hundreds of meters at certain proportion thereof;
- The shell within devices and mechanisms can be used as a consumable part;
- It is possible to program certain functions;
- Enhanced efficiency. The energy of the working/fluid medium enclosed in the elastic shell is transformed into motion and consequently sliding friction is replaced by rolling friction, thus creating a "wheel" effect;
- Low energy and material consumption: there is no need to use grease because "rigid" constructive materials are replaced by elastic materials of the shells;
- Mobile, easy to operate, repair, assemble and disassemble, particularly in extreme conditions;
- The constructive elements are universal;
- Step less control and smooth tuning and adjustment;
- Universal application;
- Minimum weight and small dimensions (at storage and transportation);
- Environmentally friendly; noiseless operation;
- Apparent poor reliability of elastic machines and mechanisms as though caused by shell's sensitivity to external mechanical impact, poor wear resistance etc. and causing its decapsulation and subsequent machine's failure is compensated by the search and / or development of composite materials being the power elements of the shell and retaining adhesive and cohesive characteristics of elastic matrix;
- These devices can operate in extremely bad environment, in a limited or unlimited space or vacuum, on and under water, in liquid and loose medium and in Cosmos;
- Apparent erratic and unpredictable behavior (movement) of elastic toroid in space is defined by correct use of its peculiarities in a particular machine or mechanism because apparent chaotic folding process at its flanks is subject of certain laws and can be controlled.

Tore Technologies and Elastic Engineering evolution

There are the simplest *spherical (one side close surfaces)* shell structures allowing simultaneous use of various working/fluid medium inside thin shell made of elastic and / or soft materials and elements of classical mechanics (arms, draws, rollers etc). These are air castings; air based supporting constructions, dams, bridges, and elements of ship frame, containers, lifting jacks, inflatable boats, soft aerostats and airships.

There are the so-called diaphragm seals intended for simultaneous separation of various fluid/working media and displacement (back- and – forth motion) of their loose part (media boundary) at minimum pressure difference between these media. These are thin-plate, disc and conical membranes, cordless sleeve gaskets, bellows, cylinders of gas-hydraulic accumulators, housings for hydraulic reservoirs etc.
The seals are made of elastic or/ and soft materials an element of classical mechanics. The shell structure is the seal hermetically connected to the case of the device.
All above mentioned machines and mechanisms are just the prototypes of elastic machines and mechanisms.

As the result of the author's information and patent investigation related to Tore Technologies it is found out:

- The invention of a vehicle and a pump with elastic toroid as the main element was first mentioned in 1963 and 1965 in the USA [22, 23];
- The first and the next fundamental basic inventions ("Pneumatic valve") were made in the USSR from 1969 till 1984 by my mentor-teacher self-taught inventor R.Z. Kozhevnikov [24-30, 32-58]. The inventions are confirmed by the working models;
- It is worth mentioning that tore based vehicle was invented at the same time in the USSR (R.Z. Kozhevnikov) [30] and in the USA [31]: Kozhenvnikov's invention was made 26 days before the American one;
- It is worth mentioning some publications, where the engineers/ journalists competently describe and illustrate Kozhevnikov's inventions [51-58];
- In the west patenting of machines and mechanisms based on tore technologies was made at single instances (maximum 5 inventions), for example [22, 23, 30];
- The first mentioning of the studies and experiments with elastic toroids (sealed cordless gaskets) dates back to 1964 in the USSR [59];
- Other inventions on tore technologies, including the author of the article [60], which appeared in Russian after 1984; do not significantly differ from Kozhevnikov's inventions.

The basic inventions on tore technologies and elastic mechanics are those inventions where new performance characteristics of elastic (tore) machines and mechanisms are defined and tested on working models, this happens for example when new design elements are added to the main element – elastic toroid:

- Endless (infinite) belt covering elastic toroid through its central part and periphery, with one or two rollers;
- A pair including elastic toroid and a roller;
- Conical elastic toroid;
- Elastic toroid with variable cross section;
- Small elastic toroid with fluid /working medium within (as a part of) a central body in a large elastic toroid filled with gaseous fluid / working medium;
- Anchoring belt is located in a central or peripheral part of elastic toroid;
- The central part of elastic toroid is twisted to provide better functioning in the machine (centering, stabilization) etc.

Almost all above described performance parameters have been achieved by R.Z. Kozhevnikov during working models testing (within 15 years).

We can drive a conclusion that Ruvim Kozhevnikov [192], a famous Russian self - taught inventor, was the founding farther of tore technologies with respect to the *development of basic functional schemes and their testing on working models*, at present he continuous his inventive activity.

Unfortunately, in the sixties – eighties tore technologies did not get deserved attention because of the lacking:

- Elastomeric constructive materials. There were available only rubber- tissue materials not very reliable for the operation in tore based machines, had big weight, produced numerous aerosol particles;
- Radio and electronic elements, modules and blocks based on thin and thick film technology;
- Textiles with required structure;
- Intellectual materials;
- Information technologies;
- There was no deficit of hydrocarbon fuel and consequently no urgent necessity to drastically increase machine efficiency and search of new, energy saving and efficient mechanics, which would require alternative environmentally pure energy sources or at least reduce significantly hydrocarbons consumption [61];
- The results of numerous investigations of natural phenomena as the form of natural elastic structures were not systemized.

At present all above mentioned research, technical, economic, social and political aspects are in place and can be put together to create elastic machines and mechanisms.

Nevertheless, there have been introduced and matured some tore based machines and mechanisms, for example:

- The machines for refurbishment of pipe systems: hose, internal coating (sanitation) of non-pressure pipes [62];
- Toys [63] etc.

Russian (Soviet) scientists, engineers, inventors and “clever fingers” - experts in specific areas who successfully developed the entire trends where tore technologies and elastic engineering are used:

- Kozhevnikova E.I. (Moscow) – wife and assistant of Kozhevnikov R.Z., transfer systems, toys [30, 50];
- Borodina L.K. (Lubertsi city of Moscow region) – earth based fast construction, filters, dams, bridges [64-68];
- Korobov A.I. (Zelenograd, Moscow) – elements of cluster tools for the production of large scale integration microelectronics: media separator, rod driver for claw mechanism, handler, vacuum and fore vacuum piston pumps, gates, mechanisms for vertical and horizontal transfer of cassettes in a production shop, containers, diagnostic and test stands [69 - 75];
- Ionova V.F. (Sergiev Pasad of Moscow region) – intellectual composite elastic material for toroidal shells;
- Gladkikh S.N. (Mytishi city of Moscow region) – development of glues and technologies for gluing materials of elastic toroids’ shells;
- Filatov V.N. (Moscow) – development of elastic textile shells as the power and intellectual base of elastic toroid’s shell;
- Larionova S.V. (Zelenograd, Moscow), Shikhirine N.V (Chicago, USA) – elastic electronics, robotics [60, 76, 93];
- Usukin V.I., Sdobnikov A.N. (Moscow) – theoretical and experimental studies of performance characteristics of tore machines and mechanisms, and curing technologies for making toroidal shell structures work [77, 78];
- Goldfeld I.Z. (Moscow) – methods of fastening pit walls, destroying old basis, pavement making [79, 80];
- Surovtsev R.A. (Malakhovka of Moscow region) – elastic toroid as identifier and measuring tool for defining the weight and geometric characteristics of an object [81, 82];
- Podolsky A.S. (Krasnodar) – conversion of waves and currents energy in electrical power, commercial technical tores (elastic toroids) as sealing devices in machines and mechanisms [83];
- Kambulov T.I. (Krasnodar) – pumps and compressors – prototypes;
- Gamsakhurdiya Sh. G. (Lubertsy city of Moscow region) – mining machines [84 - 88];
- Shalnev O.V. (Sergiev Posad of Moscow region) – modeling and calculation of static and dynamic shell structures [89, 90], including those with toroidal shape [107];
- Kozlov D.Yu. (Moscow) – structure of topological nods and interlocks to simulate pinhole surface of elastic toroids [91];
- Makarov S.S. – topologically stable (unchangeable) structures of the World Ocean water mass shaped as elastic toroids; the geometrical parameters thereof can vary without changing the topology [10];

- Sukhonos S.I. (Moscow) – natural (elastic toroids) tore whirlwinds – Tungus catastrophe, Saasov exposure, unidentified flying objects, ball lightning, formation of moon and earth crates [14];
- Goncharenko A.I. (Moscow) – information and energy packs (elastic toroids) of erythrocytes with required composition and volume generated by heart: formation and target transportation to defined organ [12];
- Kushin V.V. (Moscow) - waterspout – energy source and converter – natural elastic toroid [11];
- Vorobiev V.M. (Moscow) – intellectual property, development of patent "portfolio" on "Toroidal Motion";
- Berendyaeva T.S. (Zelenograd, Moscow) – translation into English language various tore related materials, search and creation of new English terminology to describe tore technologies and elastic engineering;
- Shikhirina T.P. (Chicago, USA) – cutting flat work pieces, sewing, gluing or welding seams, shells assembly including centering, fabrication of multi-chamber elastic toroids;
- Alferov A.S. (Izhevsk) – electronic and information technique;
- Bychkov A.N. (Zelenograd, Moscow), Kindin G.L. (Moscow) – fabrication of working models;
- Klutchnik V.O. (Moscow) – simulation;
- Shikhirin N.V. and Shikhirina E.V. (Chicago, USA) – new sections in mathematics (engineering topology, toroidal geometry and trigonometry), projects commercialization.

Those who read this section are welcome to add the researches and names controlling this process and unknown to the author.

The first basic articles devoted to tore technologies were published in 1995 with the participation of the author of this paper [69]. They describe:
- The background for effective use of tore elements (elastic toroids) in machines and mechanisms of wide application.
- Terminology;
- Classification of typical assemblies in tore machines and mechanisms;
- Tore elements in fluid/working medium energy converters;
- Materials and technology used in tore elements manufacturing.
- The technology of machines and mechanisms made on the basis of elastic toroid was called *tore technology.*
-

Tore technologies

In 1995 – 1999 the Russian company *Graderika Ltd.* based in Moscow (Zelenograd) headed by its president and the author of this paper conducted complex research works [69 – 75] aimed at developing tore based:
- Transport technologies to carry out large size (more than 1500 tons) cargo over the cross country and loose soil in extreme conditions and the means for loading / unloading the cargo;

- Construction technologies for fast erection of multi purpose structures in various climatic conditions and media;
- Pumps and compressors;
- Transfer technologies for the safe transportation of cassettes with silicon wafers and reactive chemicals within “clean room” area;
- Elements of cluster tools - gate valves, media separators, sealed loading unloading stations, mechanisms for cassettes elevation, grad vacuum conveyers, vacuum and fore vacuum piston pumps etc.

The results of the developments were tested on numerous working models.
Within these topics the following investigations were carried out jointly with Research and Development Corporation “Composite” (Korolev city) and Research and Development Corporation “Plastic” (Moscow):

- Developed design and technological options of textile materials designed for power and intellectual functions;
- Developed design and technological options of elastomer covers (elastomers, thermoplastic, polymer films), composite materials (compounds), rubber – tissue –film compositions with power, intellectual, protective and sealing functions etc.

Besides there were developed:

- Classification system, technique for testing various shape elastic toroids, requirements for elastic soft toroidal shells materials, working /fluid medium and the technical specification for the tools generating this medium;
- Technological processes for toroidal shells fabrication: direct hot molding (mold cure), jointly with Research and Development Corporation “Soyuz” (Lubertsy city);
- Layout and cutting methods for flat workpieces, gluing of calended vulcanized rubber and welding of film and tissue/ film materials etc.
- Jointly with Research Institute for Precision Machine Building and Angstrem JSC (both based in Zelenograd) developed and introduced diagnostics and test stand for studying the shells made of various materials to test the following features:

a)availability / absence of aerosol particles in the generators capable impact the technological (ambient) area;
в) reliable protection of relocated objects against shocks and vibration
c) generation/release of electro static and/or magnetic and /or other charges on interacting elements etc.

Elastic mechanics and multi-component elastic toroids

The first conceptual publications devoted to elastic mechanics whose integral part is tore technologies were published in 2000 by the author of this paper [76, 92 – 97] (see “Specific features of elastic mechanics” pages 3 – 8 herein).
The terms TORTECH and ELASTONEERING as tore marks were defended (patented) in Russia and in the USA [98-101].

All above - mentioned inventions, investigations and developments related to elastic machines and mechanisms have the main constructive element (the source or generator of toroidal motion). This is one or several single component (single cavity, single chamber) elastic toroid possessing one internal cavity (chamber) [102].
The first studies and developments included machines and mechanisms with some single-component elastic toroids, connected in specific manner into one multi-component elastic toroid as main constructive element

The specific feature of such elastic machines and mechanisms is that each machine can perform a set of operations, each being performed by one-component elastic toroids.
The main types of technical multi-component elastic toroids if compared to natural ones are:

- *Embedded* (coaxial) – comets, ball lightings,
- *Conjugated* – Benar's cells, Cuette current,
- *Linked* – The Oceanic "Conveyor Belt",
- *Combination thereof* – tornado, sandstorm etc.

For example, tore machines or mechanisms based on multi-component elastic toroids can perform direct or reversed operations: *self roll-in / self roll-out, self crawl in/ self crawl out, self evert / self screw in, self envelop /self drag out* etc.

The natural analogs of such machines and mechanisms are the biological systems that bury themselves and then crawl out to the surface.
The working models of such machines called *"It-Self Systems"* were fabricated by US corporation "*Elastoneering, Inc"* (Chicago), whose president is the author of this paper in 2002 [103, 104].
These devices can operate (function) in extreme conditions, in limited or unlimited aerial or vacuum space, on water or under water, in liquid and loose media etc.
In the working models demonstrate automatic soft grip and storage, including storage and evacuation of animals through air and under water allowing and/ or eliminating their damage. The normal vacuum cleaner working as "blower" can be used as a driving mechanism.

In order to organize business the author of this paper defended the appearance (image) of elastic toroids as the work of art [105, 106] and developed:

- Technical requirements for intellectual composite materials;
- Elastic mechanics and tore technologies application as well as the performance of elastic machines and mechanisms proven on working models;
- The list of experimental works and theoretical studies on performance characteristics of elastic machines and mechanisms – *theoretical and technological base for creating design tools* etc

Commercialization strategy

The variety of types and dimensions available for each type of elastic machine or mechanism will create new niches in the world market because:

- The machines and mechanisms based on traditional rigid mechanics are not capable of performing desirable function, for example transport technologies in the areas of permafrost
- Elastic machines have definite advantages over their analogs.

Moreover, Elastoneering Inc. expects that while the projects are developing there will appear:

- New intellectual composite materials for elastic / soft toroidal shells;
- Various types of working/ fluid media for elastic toroids, including those with controlled rheology;
- Technological processes and special process equipment to manufacture basic and accessory elements;
- Know-how, expertise, knowledge, patents, services etc.

These will become the basis for setting up mass production of elastic machines and mechanisms at low cost, with quick payback of floating assets globally (the example of Microsoft, Bill Gates).
Besides, the realization of existing projects on elastic machines and mechanisms will lay scientific and engineering foundation for design, which in its turn will become the basis for next generation of elastic tore machines and mechanisms working in various adjacent areas, including their operation in various media: on and under the water, on the ground, in the air, cosmic space etc. because the main, universal element of tore technologies - elastic toroid – has been “matured”.

The author puts forth the following objectives:

1. Study stress and deformation processes of elastic / soft shells under the action of internal overpressure and external compressive load in static and dynamic (eversion/enveloping) modes. Simulation.
2. Develop the technique for shells computation.
3. Study and develop design and technological versions of intellectual elastic composite materials used for the shells - “live layer” (mechanics and electronics represent one physical structure) with alternating moving bend, minimum friction on folds during eversion/enveloping
4. Develop diagnostic and test stands to study the shells made of various materials and the possibility of:
   - New, unknown phenomena (effects);
   - Use of above - mentioned functional features, in particular generation of aerosol particles, creation of electrical and magnetic and other fields to design new mechanic and electronic systems with new features etc.
5. Develop the systems for generation of intellectual fluid medium at overpressure.
6. Use the technology of substance transition from one phase state to another one (curing technology) and vice versa to shape operational soft and elastic shell

structures as rigid forms possessing protective functions (pneumatic tore casing, huge developable deflectors of radio-telescopes, shell-container-crypt etc.)
7. Develop new Sections in Mathematics, Electronics, Information Technology, Bionics, and Cosmology etc. For example:

- Engineering topology;
- Toroidal geometry and trigonometry (by analogy with spherical geometry and trigonometry);
- Physical meaning of the Four Color on the sphere surface, the Seven Color on toroid surface, the Six Color on a Mobius band and Klein bottle etc;
- Physical meaning of the Devil square located on a toroidal surface;
- MACROMINIATURIZATION™ as the basis of elastic electronics;
- Study the process of information, electronic and energy systems formation in natural elastic toroids to able to use this knowledge for Information, Electronic and Energy technologies of the nearest future etc.;

Conclusion

The unique feature of Tore Technologies and Elastic Mechanics is mechanics based on toroidal motion – the most stable type of motion in Nature.

- There were built tens of working models of elastic machines and mechanisms on the basis of this mechanics, whose core elements are *elastic toroids* and typical of them and conjugated with them design elements like central, peripheral bodies etc.;
- Numerous natural elastic machines and mechanisms are based on the same mechanics!;
- The same mechanics is used for generating natural energy creating gigantic natural vortex toroidal power reactors – accumulators (small comets, ball lightning, tornados, oceanic currents, cyclones etc.), where thermonuclear and other processes take place.

Today these technologies define the future of our Planet.

Those who understand Tore Technologies and Elastic Engineering and actively study and implement them will understand the main secret and mystery of Universe and the Life on Earth, and, therefore arrange their life and the life of their families and friends accordingly.

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