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TRANSPORT SYSTEM FOR DELIVERY TOURISTS AT ALTITUDE 140 km

Alexander Bolonkin

Senior Researcher of the USA National Research Council   in Eglin AFB

Former NASA Senior Research Associate

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Former NASA Senior Research Associate

Tel/Fax 850-862-6113, 718-339-4563, Bolonkin@aol.com, http://Bolonkin.narod.ru

Abstract

The author offers a new method and installation for flight in space. This method uses the centrifugal force of a rotating circular cable that provides a means for the launch of a payload into outer space, to keep the fixed space stations at high altitudes (up to 200 km) . The method may also be useful for landing to space bodies, for launching of the space ships (crafts), and for moving and accelerating other artificial apparatuses. The offered installation may be used as a propulsion system for space ships and/or probes. This system uses the material of any space body (i.e. stones) for acceleration and change of the space vehicle trajectory.

The suggested system may be also used as a high capacity energy accumulator.

Introduction

At present, rockets are used to deliver payloads into Space and to change the trajectory of space ships and probes [1]. This method is very expensive and requires a large quantity of fuel, which limits the feasibility of space stations, interplanetary space ships, and probes. The space elevator has not released a lot of years [2] . The tube rocket [3] needs more detailed research. The author offers a new revolutionary method and launch device named Bolonkin Launcher (BL) for: (1) delivering payloads and people into space, (2) accelerating space ships and probes for space flight, (3) changing the trajectory of space probes, (4) Landing and launching of space ships on space bodies with small gravity, and (5) accelerating other space apparatuses. The system may be used as a space propulsion system by utilizing the material (stones) of space bodies for propelling space apparatuses, as well as for storing energy. This method uses the centrifugal force of a closed-loop cable circle (hoop, semi-circle, double circle). The cable circle (hoop) rotates with high speed and has property of an elastic body.

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* Senior Researcher of the USA National Research Council in Eglin AFB.

The current proposal has a unique transport system for delivering loads (payloads) and energy from Earth to the space station and back. The major difficulties of this system (or whatever system is being referred to here) are in delivering the energy to the transport gondola of a space elevator and the fact that electric wire weighs a lot more than a load bearing cable. The currently proposed Space Transportation System solves this problem by locating a motor on the Earth and using conventional energy (heat, electricity, mechanical energy, etc.) to provide the power to move the gondola to the space station. Moreover the present transportation system can transfer large amounts of energy from the Earth to the Space Station (on the order of 3 to 10 Millions watt).

The author cannot find an analog for this method or similar installation in literature and patents.

1. Description of Innovation

Brief description. The Installation includes (fig.1): a closed-loop cable 1 made from light, strong material such as artificial fibers, whisker, filament, nanotubes, composite material; and a main engine 2, which rotates the cable with a fast speed in a vertical plane. The centrifugal force makes the closed-loop cable a circle. The cable circle is supported
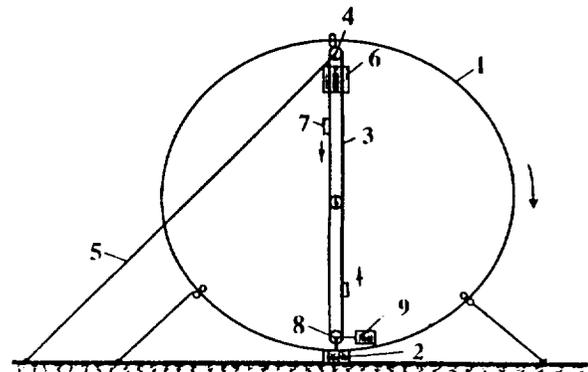

Fig.1. Circle launcher (space station keeper) and space transport system. Notations are: 1 - cable circle, 2 - main engine, 3 - transport system, 4 - top roller, 5 - additional cable, 6 - a load (space station), 7 - mobile cabin, 8 - lower roller, 9 - engine of transport system.

two pair guide cables, which connect on one end to the cable circle by a sliding connection and on the other end to the planet's surface. The installation has a transport (delivering) system 3 comprising: the closed-loop load cables (chains), two end rollers at top and bottom that can have medium rollers; a load engine; and a load. The load may be a space station, laboratory, tourist capsule, re-translator TV, radio stations, etc. The top end of the transport system is connected to the cable circle by a sliding connection; the lower end is connected to a load motor. The load is connected to the load cable by a sliding control connection.

The Installation can have additional cables 5 for increasing stability main circle. The transport system can have an additional cable in case the load cable will damaged.

The Installation works in the following way. The main engine rotates the cable circle in the vertical plane at a sufficiently high speed where the centrifugal force becomes large enough so that lifts the cable and transport system. After this, the transport system lifts the space station to space.

The first modification of the Installation is shown on fig.2. There are two main rollers 20 and 21.These rollers change the direction of the cable by 180 degrees so that the cable travels along the circle, thus creating the form of a double same semi-circle, which moves in opposite directions. This modification has a double load capability and other useful features. For example, it allows the load, which connects to one of the cables of the semi-circles, to move in any direction and to any point on the semi-circles. It can also have two engines. The others parts are same.
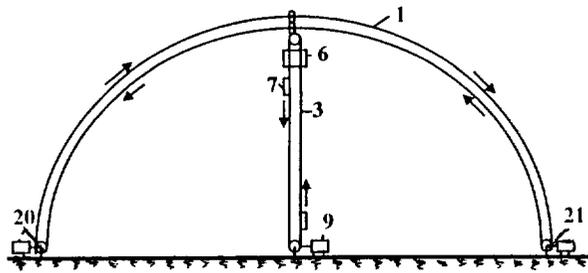

Fig.2. Semi-circle launcher (space station keeper) and transport system.

The Installation can be used for the launch of a payload (satellites, probes, etc.) to outer space (fig.3). The satellite (load) 27 is connected to the cable circle by a sliding bearing through a brake. The load is accelerated by the cable circle, lifted to a high altitude, and disconnected at the top of the circle (semicircle).

The Installation may be used as Transport system for delivery people and payload from one place to other throw space (fig.4).
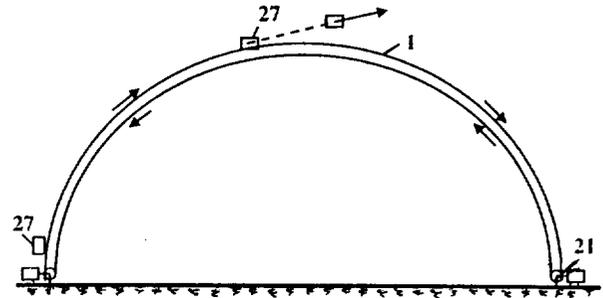

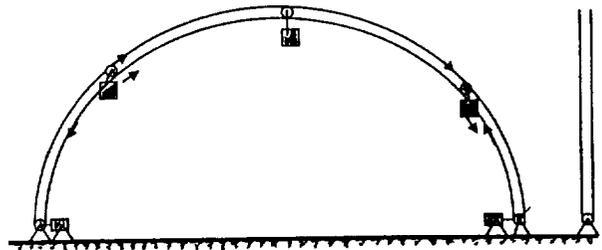Fig.3. Launching the space ship (probe) to space by cable semi-circle. 27 - load.

Fig.4. Double semi-circle with opposed speeds for delivery loads.

The double cable can be used as an excellent launch system, which generates a maximum speed 3 times the speed of cable. The launch system has a space probe 31 (fig.5) connected to the semi-circle cable and to a launch cable 33. The launch cable is connected through a roller (block) 34 to the main cable 17 at a point 35. We get the tackle block in which the maximum speed is three times more then a cable speed (fig.5).
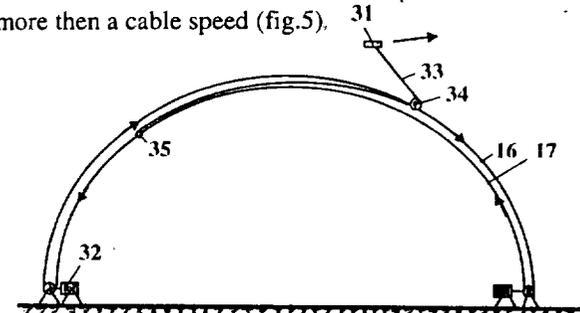

Fig.5. Launching load to Space with a triple circle rope speed by the double semi-circle.

The maximum cable speed depends on the tensile strengths of the cable material. Speeds of 4-6 km/sec can be achieved using modern fibers, whiskers, and nanotubes (see attached projects). When the space probe reaches the top of the semi-circle the probe is disconnected from main cable with a launch speed.

For stability, the Installation can have guide cables 38 connected to the top of the cable circle by a sliding connection (fig.6) and also to the ground.
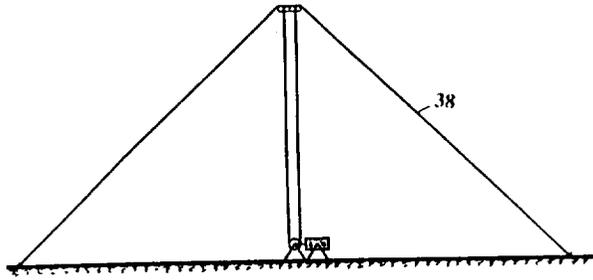
2

Fig.6. Support the semi-circle in vertical position (against precession). 38 - guide cable.

The ship installation may be used as a system for vertical landing and taking-off (launch) on or from a planet or asteroid because the cable circle can work like a spring.

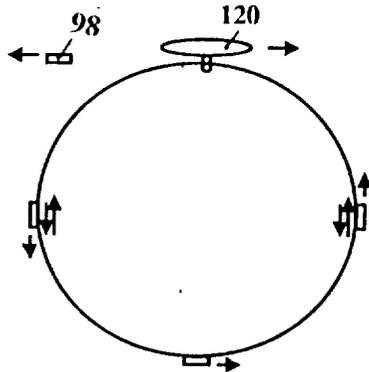The cable circle of the space ship can be used as a propulsion system (fig.7).

Fig.7. Using the rope circle as a propulsion system. Notations are: 98 – stones, 120 - space ship.

The propulsion system works in the following way: the stones from asteroids, meteorites, or garbage from the ship are packed in small packets (box, container, rack, etc.). The packet is connected to the cable circle. The circle engine turns on and rotates at a high speed. At the desired point the pack is disconnected from the circle and, as the throw back mass, flies off with a velocity, the space ship gets an impulse in the requested direction.

The suggested cable circle (double cable circle) can be made around a space body (planet), (for example, the Earth)(fig.8). This system can be used for suspended objects such as space stations, tourist cabins, scientific laboratories, observatories, or re-translators of TV and Radio stations.

This system works in the following way. The Installation has two cable circles, which move in the opposite directions with the same speed. The space stations 188 are connected to the cable circle through the sliding connection. They can move along the circle

in any direction when they are connected to one of the cable circles through friction clutch, transmission,
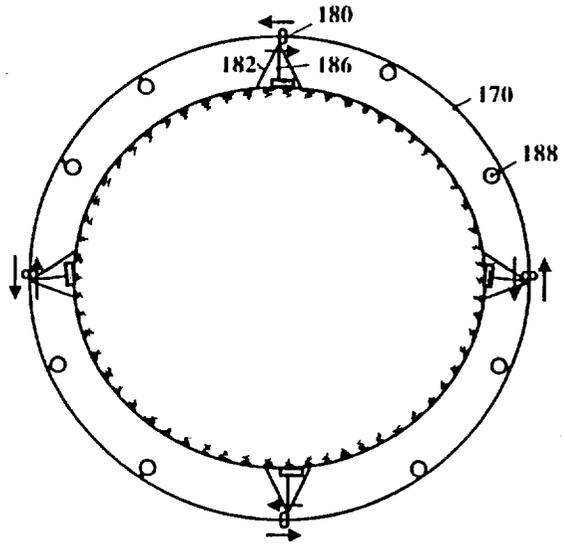

Fig.8. Rope circle around the Earth for 8-10 Space Objects. Notations are: 170 - double circle, 180 - drive stations, 182 - guide cable, 186 - energy transport system, 188 - space station.

gearbox, brake, and engine. They can use the transport system 3 in fig.1 for climbing to or descending from the station. Because energy can be lost from friction in the connections, the energy transport system 186, and drive rollers transfer energy to the cable circle from the planet surface. The cable circles are supported at a given position by the guide cables 182 (see project #2).

The Installation can have a system for changing the radius of the cable circle (fig.9). When an operator moves the tackle block 236, the length of the cable circle 248 is changed and the radius of the circle is also changed.
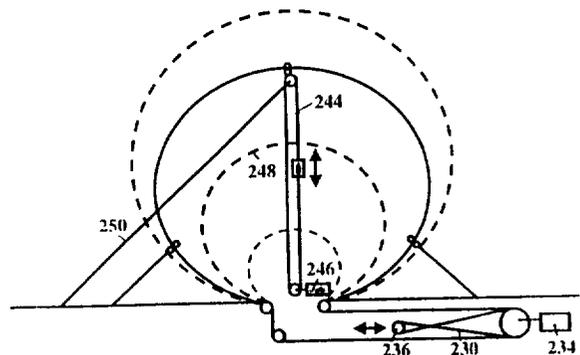

Fig.9. Radius system for changing a radius of the rope circle. Notations are: 230 - system for radius control. 234 - engine, 236 - mobile tackle block, 244 - transport system, 246 - engine, 248 - circle, 250 - guide cable.

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With the radius system the problem of creating the cable circle is solved very easily. Not necessary in the expensive rockets. The operator starts with a small radius near the planet surface (the Earth) and increases it until the desired radius is achieved.

The same method may be used for making a semi-circle or double semi-circle system.

Advantages. The main advantage of the proposed launch system is a very low cost for the amount of payload delivered to space and over long distances. Expensive fuels, complex control systems, expensive rockets, computers, and complex devices are not required. The cost of payload delivery to space would drop by a factor of a thousand. In addition, large amounts of payloads could be launched into space (on the order of thousand of tons a year) using a single launch system. This launch system is simple and does not require high-technology equipment. Any non-industrialized country could easily develop the suggested launch system and the cost is thousands of times lower than that of contemporary rocket systems.

The payloads could be delivered to space at production costs of 2 - 10 dollars per kg.

During peacetime, this launch system can be also used to deliver mail or express parcels over long distances (for example, from one continent to another). However, during war, this launch system could deliver munitions to targets thousands to tens of thousands kilometers away.

Cable problem. Most engineers and scientists think it is impossible this way to develop an inexpensive means to orbit or to travel to another planet. Twenty years ago, the mass of the required cable would not allow this proposal to be possible. However, today's industry widely produces artificial fibers, which have tensile strength 3-5 times more and density 4-5 times less than steel. There are experimental fibers (whiskers), which have tensile strength 30-100 times more, and density 2 to 5 times less than steel. For example, in the book *"Advanced Fibers and Composites"*, by author Francis S. Galasso, Gordon and Branch Science Publisher, 1989, p.158, [10], there is a fiber (whisker) C_D, which has the tensile strength H=8000 kg/mm^2 and density (specific gravity) D=3.5 g/cm^3.

The mechanical behavior of nanotubes also has provided excitement because nanotubes are seen as the ultimate carbon fiber, which can be used as reinforcements in advanced composite technology.

For example, Carbon nanotubes (CNT) have a tensile strength of 200 Giga Pascals (20,000 kg/mm^2) and a Young's modulus over 1 Tera Pascals (1999). The theory predicts 1 Tera Pascals (100,000 kg/mm^2) and Young module of 1-5 Tera Pascals. The hollow structure of nanotubes makes them very light (specific density

varies from 0.8 g/cc for SWNT's up to 1.8 g/cc for MWNT's, compared to 2.26 g/cc for graphite).

Below the author provides a brief overview of research information regarding the proposed fibers, whisper, nanotubes. In addition, the author has also solved additional problems, which appear in potential projects and which can look as difficult as the proposed space transportation technology. The author is prepared to discuss the problems with serious organizations wanting to research and develop their own projects.

2. Theory of the Circle Launcher

Formulas for estimation and computation developed or used by A. Bolonkin (in metric system)

1. Let us take a small part of a rotary circle and write it equilibrium

$$2SR\alpha\gamma V^2/R = 2S\sigma sin\,\alpha.$$

where V is rotary cable speed [m/s], σ is cable tensile stress [n/m^2], γ is cable density [kg/m^3], S is cross-section area of cable [m^2], R is circle radius, α is angle of part.

When $\alpha\rightarrow 0$, relationship between maximum rotary speed and tensile strength of closed-loop circle cable is

$$V=(\sigma/\gamma)^{1/2}=k^{1/2}, \qquad (1)$$

Result of computation is presented in fig.10.

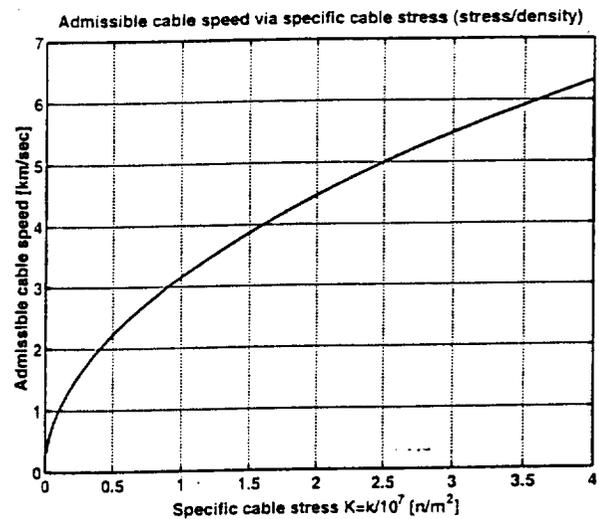Admissible cable speed via specific cable stress (stress/density)

Fig.10. Maximum cable speed via an admissible specific cable stress.

2. Maximum lift force P_{max} [n] of the rotary closed-loop circle cable when the gravity $g=0$:

$$P_{max}=2V^2\gamma S=2\sigma S. \qquad (2)$$

We can use approximately 0.25 of this force. Result of computation is presented in fig.11.

3. Maximum vertical lift force P [n] of the vertical cable circle in the gravity field of a planet (g = constancy) equals (2) minus a cable weight

$$P=2S(\sigma - \pi R \gamma g).\qquad(3)$$

where g is the specific gravity of the planet (for the Earth $g=9.81$ m/s^2 on the altitude $H=0$).

4. Maximum lift force P [n] of the semi-circle cable in the gravity field of a planet is

$$P=2S(\sigma - 0.5\pi R \gamma g).\qquad(4)$$

5. Specific lift force of 1 kg of cable mass P_1 in a planet's gravity field [kgf/kgm] equals the lift force (3) divided on the cable weight

$$P_1=(\sigma/\gamma R)\cdot g,\qquad(5)$$

Lift force of S=1 mm² cable via cable stress
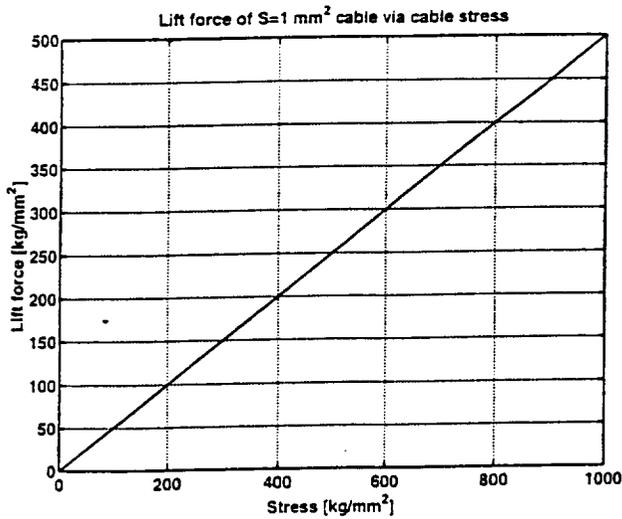
Fig.11. Maximum lift force of cable S=1 mm^2 via stress.

6. Specific lift force P_L of 1 m of cable in a planet's gravity field [kgf/m] equals the lift force (3) divided on the cable length

$$P_L=S[(\sigma/R)-\gamma g],\qquad(6)$$

7. Length of a cable L [m], which supports the given local load P [kg] is

$$L=P/P_L.\qquad(7)$$

8. Cable angle to the horizon about a local load equals (from local equilibrium)

$$\alpha=\arg\sin(P_L/2\sigma S).\qquad(8)$$

9. Cable deformation about a local load (decreasing in altitude) [m] for a cable semi-circle in a planet gravity's field approximately equals

$$\Delta h \cong P_L^2/12\sigma S^2(\sigma/R -\gamma g).\qquad(9)$$

10. Cable deformation about a local load for the cable circle around a planet in Space is

$$\Delta h \cong (R/12)(P_L/\sigma S)^2.\qquad(10)$$

11. Internal pressure on the cable circle we can receive from equilibrium condition. Result is

$$p = \pi r \sigma/2R = \pi r \gamma V^2/2R,\qquad(11)$$

where r is the radius of cable or a half of cable width.

12. Increasing the cable radius under an internal pressure

$$\Delta R = \gamma V^2 R/E,\qquad(12)$$

where E is Young's modulus.

13. Maximum cable radius in a constant gravity field (g = const) can beget from equilibrium the lift force and a cable weight

a) Full circle

$$R_{max} = \sigma/\pi \gamma g.\qquad(13)$$

b) Semi-circle

$$R_{max} = 2\sigma/\pi \gamma g.\qquad(13a)$$

Result of computation is presented in fig.12.

Maximum radius of Earth cable semi-cicle [km]
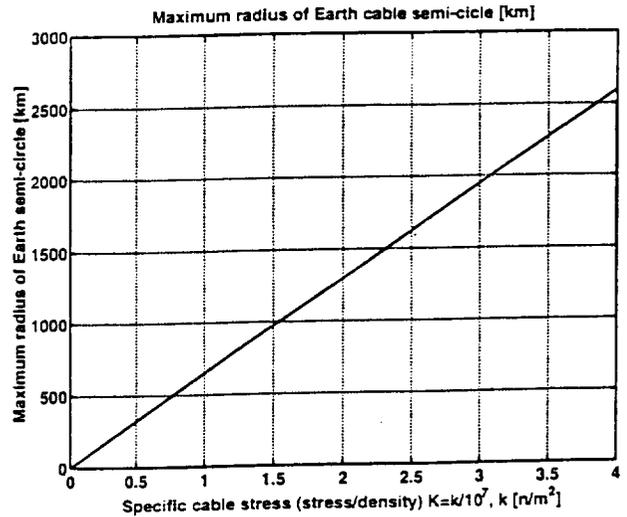
Fig,12. Maximum radius of Earth semi-circle via specific cable stress.

14. Maximum cable radius in a variable gravity field of a rotary planet (can be find from the equation of a circle located on Equator)

$$R[(1 + R/R_o)/(1+2R/R_o)^{3/2} - \omega^2(R_o+R)]= \sigma/\pi \gamma g,\qquad(14)$$

where R_o is the radius of planet, ω is a planet angle speed [rad/sec].

15. Maximum speed of a closed-loop circle around of a planet can be find from equilibrium a centrifugal and a gravity forces

$$V = [(\sigma/\gamma) + Rg]^{1/2}.\qquad(15)$$

Result of computation is presented in fig.13.

16. Full lift force of a closed loop cable circle rotated around of a planet is

$$P = 2\pi\sigma S.\qquad(16)$$

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Result of computation is presented in fig.14.

17. Specific lift force of a 1 kg closed loop cable circle rotated around a planet can be got from (16), if it divides on cable weight

$$P_I = \sigma/\gamma R . \qquad (17)$$

18. Specific lift force of a 1 m closed loop circle around a planet in space, when $g=0$, can be got from Eq. (16), if it divides on the cable length

$$P_L = S\sigma/R . \qquad (18)$$

19. We can receive from momentum theory an additional speed, ΔV, which a Space ship gets from a cable propulsion system

$$\Delta V = V_c m/(m_{ss}-m), \qquad (19)$$

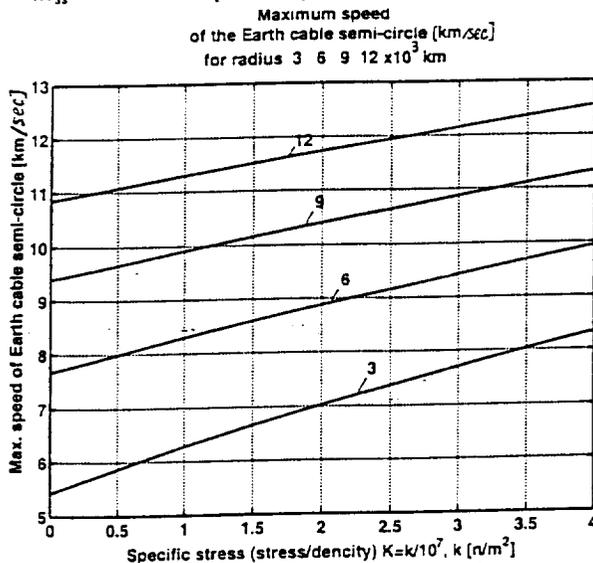where m is a throwing mass, V_c is mass speed, m_{ss} is mass of a space ship.

Maximum speed
of the Earth cable semi-circle [km/sec]
for radius 3 6 9 12 x10³ km

Fig.13. Maximum speed of a closed-loop circle around of a planet,

Full lift force of a closed-loopcable circle
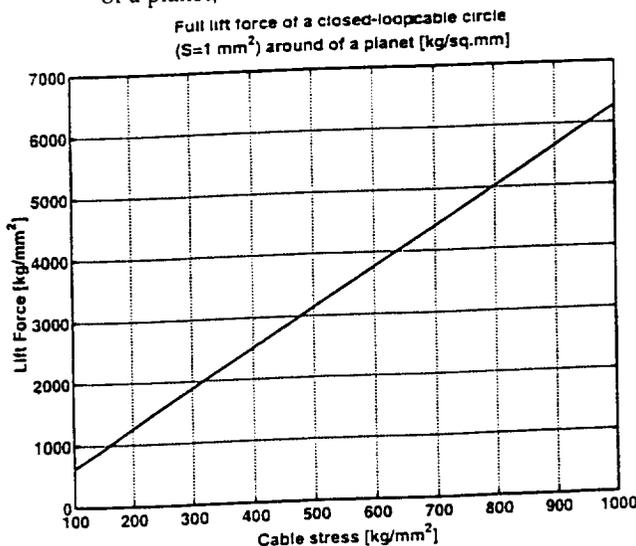(S=1 mm²) around of a planet [kg/sq.mm]

Fig.14. Full lift force of the closed-loop cable circle rotated around of a planet.

20. Speed of falling from an altitude H

$$V = (2gH)^{0.5} . \qquad (20)$$

21. Energy, E, storaged by a rotary circle per 1 kg of the cable [joules/kg] can be got from known equation of kinetic energy. Equation is

$$E = \sigma/2\gamma , \qquad (21)$$

22. Radius of observation via altitude H [km] over Earth

$$R = (2R_oH + H^2)^{0.5} \text{ [km]} , \qquad (22)$$

where Earth radius R_o=6378 km. If H=150 km, R=978 km.

23. **Estimation of cable friction due to the air.**

This estimation is very difficult because there is no experimental data for air friction of an infinitely very thin cable (especially at hypersonic speeds). I used a computational method for plates at hypersonic speed described in the book "Hypersonic and High Temperature Gas Dynamics" by J.D. Anderson, p.287, [8]. The computation is made for two cases: laminar and turbulent boundary layer.

The results compare very differently. The maximum friction is for turbulent flow. About 80% of the friction drag occurs in the troposphere (from 0 to 12 km). If we locate the cable end on mountain at an altitude of 4 km the maximum air friction decreases by 30%. So I will calculate the drag for three cases: when the cable end is located on the ground (H=0.1, 1 km,) and when it is located on the mountain at H=4 km (2200 ft).

I think that most part of cable will have the laminar boundary layer because a small wind will blow away the turbulent layer and restore the laminar flow. The blowing of the turbulent boundary layer is studied in aviation and is used to restore laminar flow and decrease air friction. The laminar flow decreases the friction in hypersonic flow by 280 times! If a half of cable surface has a laminar layer it means that we must decrease the air drag calculated for full turbulent layer by a minimum of two times.

Below I give the equation from Anderson [10] for computation of local air friction for a plate.

$$(T^*/T) = 1 + 0.0032M^2 + 0.58(T_w/T_e -1) ;$$

$$\mu^* = 1.458 \cdot 10^{-6} T^{*1.5}/(T^*+110.4) ; \quad \rho^* = \rho T/T^* ;$$

$$Re^* = \rho^* Vx/\mu^* ; \quad C_{f,l} = 0.664/(Re^*)^{0.5} ;$$

$$C_{f,t} = 0.0592/(Re^*)^{0.2} ;$$

$$D_L = 0.5 C_{f,l} \rho^* V^2 S ; \quad D_T = 0.5 C_{f,t} \rho^* V^2 S .$$

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Where: T^*, Re^*, ρ^*, μ^* are reference (evaluated) temperature, Reynolds Number, air density, and air viscosity. M is Max Number, T_w - temperature of wall (cable), T_e - temperature of flow, V is speed, x is length of plate (distance from the beginning of the cable). C_{fl} is a local skin friction coefficient for laminar flow, C_{ft} is a local skin friction coefficient for turbulent flow. S is area of skin [sq.m] of both plate sides, it means for cable we must take $0.5S$; D is air drag (friction) [n]. It may shown, that the air drag for the cable equals $0.5(D_T+D_L)$, where D_T is turbulent drag and D_L is laminar drag.

There are also the simplest formula of a friction F [n] gives the more realistic result

$$F = \mu VS/w ,\qquad(23)$$

where $\mu = 1.72 \cdot 10^{-5}$ is air viscosity, $w = 2.5d$ is thickness of a boundary layer, d is a cable diameter, S is surface of cable.

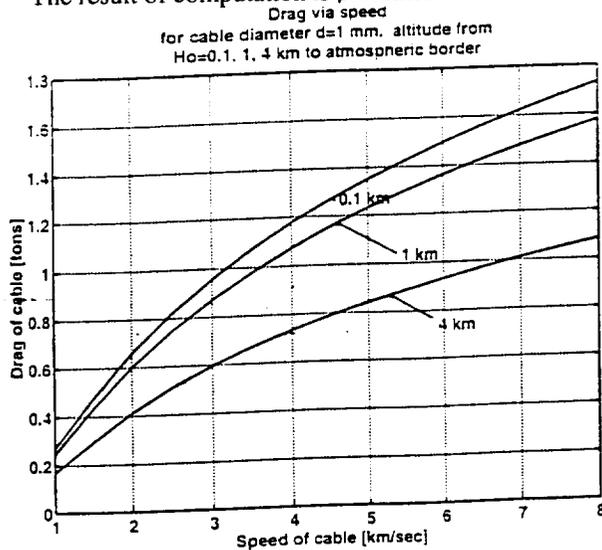The result of computation is presented in fig.15.

Drag via speed
for cable diameter d=1 mm. altitude from
Ho=0.1, 1, 4 km to atmospheric border

Fig.15. Estimation of friction air drag via speed and length of cable.

3. Data used for computation

Let us consider the following experimental and industrial fibers, whiskers, and nanotubes.

1. Experimental nanotubes CNT (Carbon nanotubes) has a tensile strength of 200 Giga-Pascals (20,000 kg/sq.mm), a Young's modulus of over 1 Tera Pascal, and a specific density of γ=1800 kg/m^3 (1.8 g/cc)(2000 year). For a safety factor of n=2.4, we can use σ=8300 kg/mm^2=8.3$\cdot$10^{10} n/m^2 and γ=1800 kg/m^3, or (σ/γ)=46x10^6, K=4.6. About 300 kg of nanotubes will be produced in the USA in 2002.

2. Whiskers C$_D$ have σ=8000 kg/mm^2 and γ=3500 kg/m^3 (1989). We take for computations: σ =7000kg/mm^2, γ=3500kg/m^3, σ/γ=20x10^6, K=2.

2. Industrial fibers have σ=500-650 kg/mm^2 and γ =1800 kg/m^3, or σ/γ=2,78x10^6.

Project #1

Space Station for Tourists or a Scientific Laboratory at an altitude of 150 (140) kilometers (figs.2-6)

The closed-loop cable is a double semi-circle. The radius of the circle is 150 km. The Space Station is a cabin with a weight of 4 tons (9000 LB) at an altitude of 150 km (94 mils). This altitude is 140 km under load.

Results of computations for three versions (different) cable strengths of this project are in Table 1 .

Table 1

# variants	σ kg/mm^2	γ kg/m^3	σ/γ 10^7[m]	V km/c	H km	S mm^2
1	2	3	4	5	6	7
1	8300	1800	4.6	6.8	2945	1
2	7000	3500	2.0	4.47	1300	1
3	500	1800	0.28	1.67	180	100

P_{max}[tons]	G kg	Lift force kg/m	Loc.load kg	L km	α^p	ΔH km
8	9	10	11	12	13	14
15.75	1696	0.0534	4000	75	13.9	3.0
12.35	3282	0.0466	4000	86	16.6	4.4
15.20	170x10^3	5.34	4000	0.75	4.6	0.17

Cable Thrust T_{max} kg	Cable drag H=0km,kg	Cable drag H=4km,kg	Power MgW H=0 km	PowerMgW H=4 km	Max.Thrust ton	Tourists men/day
15	16	17	18	19	20	21

8300	1100	710	150	97	8.23-7.6	768
7000	880	600	135	75	6.12-6.4	700
50000	4000	2230	134	74	47.8-46	400

The column numbers are: **1)** the number of the variant; **2)** the permitted maximum tensile strength [kg/sq.mm]; **3)** the cable density [kg/cub.m]; **4)** the ratio $\sigma/\gamma\ 10^{-7}$ [m]; **5)** the maximum cable speed [km/s] for a given tensile strength; **6)** the maximum altitude [km] for a given tensile strength; **7)** the cross sectional area of the cable [sq.mm]; **8)** the maximum lift force of one semi-circle [ton]; **9)** the weight of the two semi-circle cable [kg]; **10)** the lift force of one meter of cable [kg/m]; **11)** the local load (4 tons or 8889 LB); **12)** the length of the cable required to support the given (4 tons) load [km]; **13)** the cable angle to the horizon near the local load [degrees]; **14)** the change of altitude near the local load; **15)** the maximum cable thrust [kg]; **16)** the air drag on one semi-circle cable if the driving (motor) station is located on the ground (an altitude H=0), the minimum is (1/140) for a laminar boundary layer and the maximum (it is shown) is for a half turbulent boundary layer; **17)** the air drag of the cable if the driving station is located on a mountain at H=4 km; **18)** the power of the driving stations [MgW] (two semi-circles) if located at H=0; **19)** the power of the driving stations [MgW] if located at H=4 km; **20)** the maximum thrust of cable without air drag; **21)** the amount of tourists (tourist capacity) per day (0.35 hour in Station) for two semi-circles.

Economic Estimations of these projects for Space Tourism.

Let us take the weight of the tourist cabin as 2 tons (it may be up 4 tons), and the useful payload as 1.3 tons (16 tourists plus one operator). Acceleration (braking) is 0.5g (a=5 m/s). Then the time to climb and descend will be about 8 minutes (H=0.5at^2) and 20 minutes for observation at an altitude 150 km. The common flight time will be 30 minutes. The passenger capability will be about 800 tourists per day.

Let us take the cost of the Installation as $10 million, the installation life time as 10 years, the number of employees as 20 men with an average salary of 50K per year, and the cost of aviation fuel as 0.25 $/liter. Then the production cost of a space trip for one tourist will be equal to $165 (about 95% of this cost is the cost of fuel and we do not know exactly the needed energy). If the cost of the trip ticket will be $100 more than the production cost, the Installation will give a profit of about $56 million per year. This profit may be larger if we design the Installation especially for tourism. For example, if the capacity of the cabin is 160 tourists the production costs decrease by 3 times (55 $/man). If our engines use natural gas (not benzene), the production cost decreases by the same ratio that gas cost is to benzene.

Discussing of the project 1. 1) The first variant has a cable diameter of 1.13 mm (0.045 inch) and a general cable weight of 1646 kg (3658 LB). It needs a Power (engine) Station to provide from 75 to a maximum of 150 MgW (the maximum amount is needs additional research). The maximum is a power of 15 aviation turbo-engines. Maximum altitude is 150 km (94 miles) and the tourist capacity is about 770 people/day.

2) The last (#3) variant uses a cable with tensile strength near that of current fibers. The cable has a diameter of 11.3 mm (0.45 inch) and a weight of 170 tons. It needs an Engine to provide from 74 to 133 MgW, and has a tourist capacity of 400 people per day.

The Systems may be used for launching (up to 1 ton daily) satellites and interplanetary probes. The Installation may be used as a relay station for TV, radio, and telephones.

Project #2
Circle around the Earth at an altitude of 200 km (125 miles) for 8-10 scientific laboratories (fig.18)

The closed-loop cable is the circle around the Earth at an altitude H of 200 km (125 miles). The radius is 6578 km. The Space Stations are 8-10 cabins with a weight of 1 ton (2222 LB)).

Results of Computation for three versions are in Table 2.

Table 2

#	σ kg/mm^2	γ kg/m^3	V km/s	S mm^2	P_{max} [tons]	Weight [tons]	Lift force [kg/km]	Angle α [degree]	W [kg]	ΔH [km]
1	2	3	4	5	6	7	8	9	10	11
1	8300	1800	10.53	1	52.1	74.4	1.26	3.45	86.4	7.9
2	7000	3500	9.19	1	44	145	1.06	4.1	200	11.2
3	500	1800	8.06	10	31.4	744	0.76	5.74	500	22

1. The numbers note: 1)Number of variants; 2)Tensile strength [kg/sq.mm]; 3) Cable density [kg/cub.m]; 4) Cable speed [km/s]; 5) Cross sectional cable area [sq.mm]; 6) Maximum cable lift force [tons]; 7) Cable weight [tons]; 8) Lift force of 1 km of cable [kg/km]; 9) Cable angle to the horizon near a local load [degrees]; 10) Cable weight in a load 1-ton cabin (capsule)[kg]; 11) Change (decreasing) of the altitude under a local load 1 ton [km].

Discussing of the project 2. The variant 3 using current fibers (σ=500 kg/sq.mm; 5000 MPa) has a cable diameter of 3.6 mm (0.15 inch), a cable weight 744 tons, and can keep 10 Space Stations with useful loads (200-500 kg) for each Station at an altitude of 180 km (112 miles). This may also be used for launching small (up to weight 200 kg) satellites.

General discussing

Science laboratories have whiskers, nanotubes which have a high tensile strength [4]-[7]. The theory shows that these values are only one tenth of the theoretical level. We must study how to get a thin cable, such as the strings or threads we produce from cotton or wool, from whiskers and nanotubes.

The fiber industry produces fibers, which can be used for some of the author's projects at the present time. About 300 kg nanotubes will be produced in the USA in 2002 (Ch.&Eng.,Oct.8,2001). These projects are unusual (strange) for specialists and people now, but they have huge advantages, and they have a big future. The government must award scientific laboratories and companies who can get a cable with the given performances for a reasonable price.

The reader can find the others author ideas about non-rocket space flights in [3],[10]-[16].

Patent applications are 09/873,985; 09/789,959; 09/978,507 (2001).

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