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Aerostatic method of transportation of big quantities of gas and liquid fuel

Beginning with the first issue of the "Montgolfier" journal we demonstrate, how the aerostation can favour the economical development of the state and contribute to its prosperity and defence.

In order to continue the discussion we started, this issue of the Montgolfier contains information concerning new usage of lighter-that-air vehicles, particularly about the fact, that the aerostatic method of fuel transportation, which is much more economic and profitable, may be used instead of the traditional one. In the mid-Seventies, which was the period of so-called "fuel crisis", this method was suggested to the State Planning Commission of the former UAAR as an alternative, that excluded the use of thick-walled steel pipes, large in diameter. These pipes were necessary to construct new pipelines of high productivity, because new rich oil-and-gas stocks in Siberia were discovered, in the region of Urengoy-Medwezhje.

This suggestion allows to solve the problem of long distance transportation of big amounts of natural gas (methane) with minimal energetic costs, minimal capital investment and with a possibility to put the system of transportation in action in short time. The elaboration of this suggestion is a part of our project of Aerostatic Atmosphere Opening Up System (SAOAT) ("Montgolfier" journal №1).

The physical base of this suggestion includes:

- The use of aerostatic lift force of the natural gas (methane), that makes approximately 0,5 kg\m^3 in reference conditions at the sealevel.

- The possibility to achieve small specific resistance to the travel of the gas put in a container of large diameter. The surplus of the aerostatic lift force must be equilibrated by ballast. This could be the transported liquid fuel (condensate, oil, liquefied gas or methanol)

- Relatively small quantity of material, necessary to put the transported gas and liquid fuel into streamlined containers, that float in the atmosphere, and to translocate them at speed of approximately 100 km\h

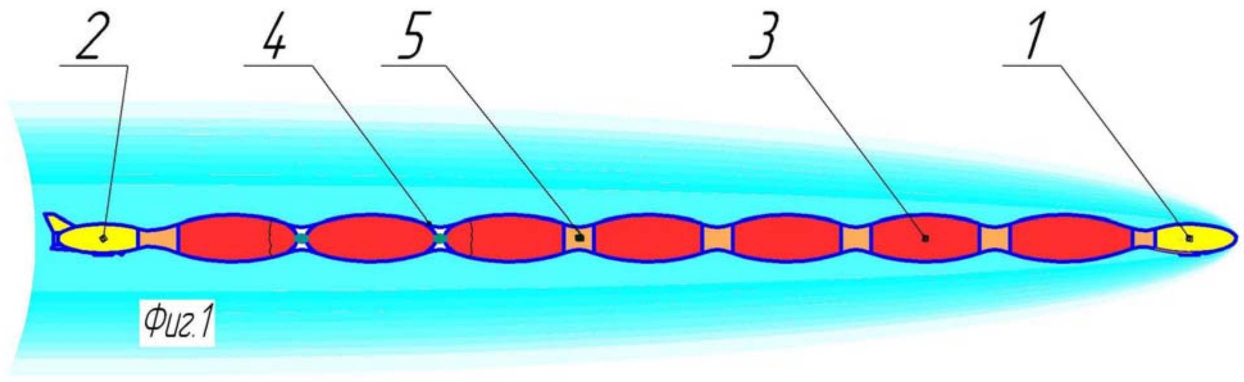
The calculation shows the following. If the work needed to transport the given quantity of gas (Gg) on the given distance (Ltr) with the help of aerostatic method is designated as Asaft and the work needed to transport the same quantity of gas (Gg) on the same distance (Ltr) with the help of pipeline method is designated as Apipe, then the correlation Asaft/Apipe is essentially lower than 1. So we can see, that the work necessary to transport the given quantity of gas on the given distance with the help of aerostatic method is significantly smaller than the analogous work performed with the help of pipelines.

The technical basis of this decision is a great quantity of achievements of modern technique:

- synthetic sheet substances used to create towed fuel-carrying balloon
- air turbo-prop power-plants necessary to create the trust to move them
- the elaboration of the projects of modern rigid airships, that satisfy all the demands of maximum security

The schematic solution of the System of Aerostatic Fuel Transportation (SAFT).

The SAFT schematically looks like this:



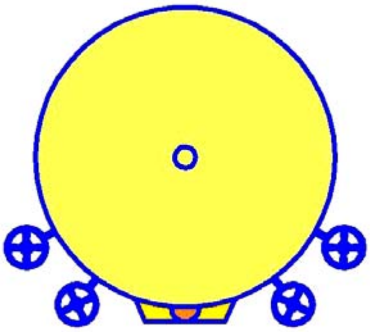
Фиг.1

An aerostatic fuel train (AFT) in its flight with freight. The towing airship – 1; the airship-stabilizer – 2; the towed fuel-carrying balloon – 3; contoured adapter connectors – 4; hinge-joint assemblies – 5.

The natural gas is pumped into single so-called towed fuel-carrying balloon (TFCBs) of the changeable form, which get in such a way the aerostatic lift force, which exceeds the weight of their construction. In order to bring the balloon to the balanced, floating state they are loaded with liquid fuel, and it works as ballast.

With the help of hing-joint (made of fuel-carrying balloons, affiliated to each other) an aerostatic fuel train (AFT) is made. In front of the train a towing airship D-1T is attached, and behind it – an airship-stabilizer D1-S (it provides immunity and manoeuvrability on all the stages of movement), in order to haul the whole train. Both airships have significantly smaller size, than the towed TFCBs and are the modifications of the serial airship D1 (we spoke about it in details in the first issue of the “Montgolfier”).

In order to prevent whirling in the places where the balloons are jointed, contoured adapter connectors are set between them. They transform the AFT into one streamlined body.

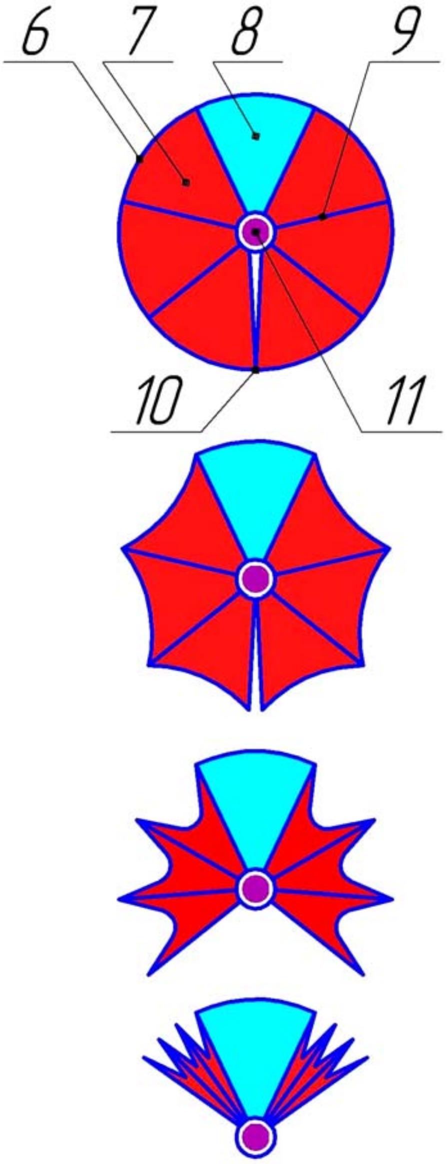


Фиг.2

The towing airship, front view.

Arrived to the place where the fuel must be unloaded, the towing airship performs tethering and mooring to a rotary platform of a berthing tower. The platform must be wind-oriented. From this platform a consecutive decoupling of the TFCBs is performed and each of them is towed on it’s wind-protective parking. Here the liquid and gas fuel is pumped out of them.

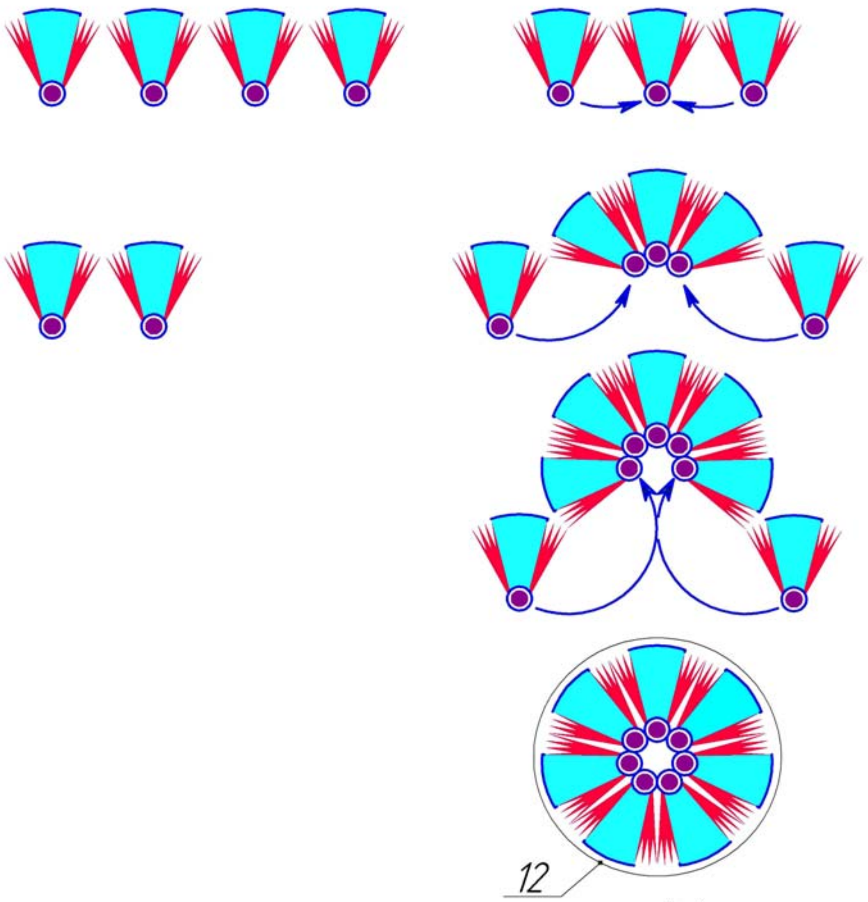
The construction of TFCB assumes it’s folding while the fuel is pumped out (fig.1-5). On the fig.3 a sectional view of a TFCB is shown. An TFCB is divided into seven bays, compartments by longitudinal flexible diaphrgmes (9). Six bays (7) contain the transported gas and one bay (8), a so-called returnable bay, contains worked gas, which is not pumped out. I’s volume balances all the construction of a TFCB.



Фиг.3

The change of the shape and the stages of fuel unloading from the towed fuel-carrying balloon (from the initial (full-freighted) till the final (with the worked gas, which is never pumped out).

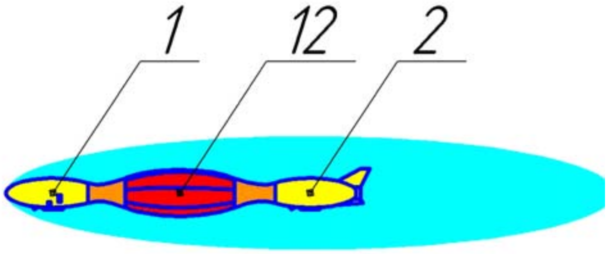
The pivot of the construction and the axis of rotation is the central steel tube (11), which is also the container of liquid ballast. The diaphragm (9) move around this tube when a TFCB is folding and the gas is pumped out. All the diphragmes, that divide the internal chamber of a TFCB into bays, are single, except of the first and the seventh, the bottom ones. The 1st and the 7th bays are divided by double diaphragmes, which is locked up (10) when the TFCB is full. When the gas is being pulled out, the lock starts opening and as the gas is pulled out the internal chamber of a TFCB transforms according to the stages, shown on fig.3. The sheath (6) under effect of the folding diaphragmes becomes pleats adjoining the returnable bay. These unloaded TFCBs then form a single block (12). Its shape is similar to the shape of one loaded TFCB (fig.4).



Фиг.4

The stages of the forming of a single block balloons from unloaded TFCBs

This train consists of a towing airship, a single block of unloaded TFCBs and an airship-stabilizer. The speed of this short train on returning is approximately 1,5 times higher. That is caused by decreasing of the coefficient of the aerodynamic drag of the train. Accordingly it decreases the operating cost of the system, for it works as a ***cyclic closed-loop system of fuel transportation***.



Фиг.5

The short train, made to return to the place where the new portion of fuel will be loaded.

Three variants of an AFT are considered, depending on the diameter (capacity) of one TFCB.

The variant	The diameter of a TFCB (meters)	The capacity (gas, million m^3)
1	60	1,9
2	80	4,7
3	100	9,4

In order to haul an AFT at the speed of 100 km\h (this speed is chosen because of the condition of limitation of wind influence on navigation) an ATP requires a trust of:

1st variant – 12500 kg
2nd variant – 22000 kg
3rd variant – 34000 kg.

We propose to use additional (bearing on a series airship D1) turboprop engines as propulsion engines on the towing airship D-1T. These additional turboprop engines must be modified so that they can use the transported natural gas as fuel. This decreases the costs significantly and simplifies the system of aerostatic regulation during the flight. These engines are a part of additional equipment of the front towing airship. They are hanged on the pylons from below, on the sides of the cargo hold of the airship, near its mid-section. The engines have a special cowling that includes the rings of the screw and control jets (fig.2).

The fuel is delivered to the engine from the first towing balloon. As we know that there is an experience of supplying the turboprop engines with natural gas, we consider it technically realizable to supply a part of the engines with liquid, and another part – with gas fuel.

With weight relation between the spent liquid fuel and the spent gas fuel 2:3, the consumption of the fuel doesn't change the state of balance of the front TFCB.

In order to be able to transfer the link of the power-plant to the towed airships, the airship D-1T is equipped with a tow system. D-1T and D-1S are equipped with the systems of remote control of the basic parameters of the state of the train.

To finish this short description of the next chapter of the SAOAT, I'd like to give an unchanged quotation from the Conclusion of the State Expert Commission:

"Taking into account the updating of the data of the economical section of the project, the expertise considers to be real the following comparative characteristics of the SAFT and the pipeline transport:

The variant of transport*	Specific data		
	Capital investments	Operational costs	Settlement costs
1. AFT-2, 100 billion m^3\year, 3000 km	0,25	0,13	0,16
2. AFT-1, 50 billion m^3\year, 1000 km	0,61	0,3	0,375
3. Condensat pipeline, diameter 1200mm, 3283 km	0,75	0,1	0,19
4. Gas pipeline, diameter 1420 mm, northern regions	3,3	0,22	0,62
5. . Gas pipeline, diameter 1420 mm, middle zones	1,5	0,2	0,38

*Note: The expertise didn't consider necessary to perform calculations for the AFT-3, because for the use of this variant is hardly possible to find adequate conditions.