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The Pipe-Pump Integration in the "Airborne Pipeline Docked to an Earth Reservoir to Deliver Water over Long Distance for Aerial Firefighting and Irrigation" System

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Abstract: The main idea of the invention is to use a long flying pipeline to deliver water to a forest fire. Another use could be to irrigate large areas in emergency situations. Our solution to transfer water with an airborne pipeline is several thousand times more efficient. A typical 16-inch plastic pipe gives a water flow of s 7281 m^3 per hour or 2427 times more water on target than the helicopter. The general functionality of the invention is very simple. The water is elevated from the basin with the pumping station through the long pipeline. It finally ejects water from the pipeline endpoint to the forest fire. The crucial difference is that the pipeline flies above the hills hanging from hundreds of drones. The above pipe needs a special pump. The pump lies at the inner surface of the pipe, it is very small and there are more than one in every meter of the pipe. The airborne pipeline is under pre-alpha test today waiting for the final European Patent Office approval. However the coaxial pipe inner booster is a very innovative approach that is not limited to airborne pipeline use. Our ambitious are far to replace the traditional pump withits unique smoothly operation. Of course serious mathematical modelling is necessary before to proceed to the next pre alpha step (or test).

Keywords: Forest Fire, Drone Technology, Hydraulics Applications, Irrigation, Agriculture, Natural Resources, Environment, Environment and Growth, Environmental and Ecological Economics

1. Introduction

Pumping systems account for nearly 20% of the world's energy used by electric motors and 25% to 50% of the total electrical energy usage in certain industrial facilities. Significant opportunities exist to reduce pumping system energy consumption through smart design, retrofitting, and operating practices. In particular, the many pumping applications with variable-duty requirements offer great potential for savings. The savings often go well beyond energy, and may include improved performance, improved reliability, and reduced life cycle costs.

Most existing systems requiring flow control make use of bypass lines, throttling valves, or pump speed adjustments. The most efficient of these is pump speed control. When a pump's speed is reduced, less energy is imparted to the fluid and less energy needs to be throttled or bypassed. Speed can be controlled in a number of ways, with the most popular type of variable speed drive (VSD) being the variable frequency drive (VFD) [1]

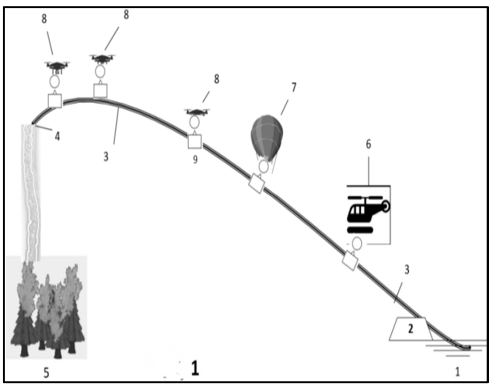

Figure 1. *Conceptual Schema.*

Solve for fluid or liquid velocity

Where

- WHP, =, water horsepower
- Q, =, flow rate or discharge
- H, =, total head
- n, =, pump efficiency
- BHP, =, brake horsepower
- NPSH, =, net positive suction head
- V, =, velocity of fluid or liquid
- p, =, impeller inlet pressure
- p_v, =, vapor pressure of fluid or liquid
- SW, =, specific weight of fluid or liquid
- g, =, acceleration of gravity

$$V = \sqrt{2g(\mathrm{NPSH} - \frac{p}{SW} + \frac{Pv}{SW})}$$

Flow equations in simplified form [2]

2. Functional Description

Invention technical field areas are:

- Forest fire fighting,
- Water pipelines,
- Drone technology and applications,
- Forest fire fighting,
- Agriculture irrigation.

Existing forest fire fighting resources and methodology are inefficient in spatial temporal: “too less water to late”. [3, 4, 5]. Earth firetrucks cannot come close to the fire. Airplanes carry a lot of water by they cannot target the fire. Helicopters approach accurately the fire but they only deliver a few drops every second. All these only at daylight.

The main idea of the invention is to use a long flying pipeline to deliver water to a forest fire. Another use could be to irrigate large areas in emergency situations.

Current technology, far or less, faces the fire extinguish traditionally with the same approach. They carry water to the fire area with trucks, airplanes and helicopters. The most efficient way is the helicopter ejecting a ton of water in every flight. According to our calculations the time frame between two water unloads exceeds on average the twenty minutes. That is 3 tons of water per hour and only during daytime.

Our solution to transfer water with an airborne pipeline is several thousand times more efficient. A typical commercially available plastic pipe of 16 inch runs at the highest water velocity of 3.9 m^3/sec. It delivers an amazing water flow of 2.02 m^3/sec. That is 7281 m^3 per hour or 2427 (two thousands four hundred and twenty-seven) times more water on target than the helicopter.

All normal pipe components and pumps are designed for continuous operation. In our case the operation it will last a few minutes per fire therefore cheaper components are acceptable.

The main idea of the invention is to pump water from a lake, dam or sea into a pipeline while the other pipe endpoint flies over the hills. It finally delivers several tons of water per minute accurately into the forest fire.

To describe the invention, we attach 4 drawings. The drawing number 1, describes the conceptual operation schema and field application of the invention, number 2 gives details of the pumping station and drawing 3 the engineering details of the pipe connector and flying hub.

Drawing number 1, describes the conceptual operation schema and field application of the invention. There are nine cooperating items:

- The water reservoir (1) could be a sea, lake or artificial dam.
- The pumping and electricity supply station (2),

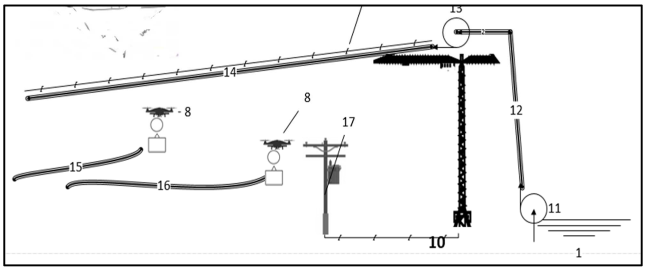

Figure 2. *Pumping Station chaos.*

- The airborne pipeline (3),
- The water ejection pipeline end-point (4),
- The forest fire to be eliminated (5),
- The optional helicopter (6) and balloon (7) elevation options,
- The constituting pipes connection hub (9) hanging from the drone flying platform (8) [6, 7, 8]

Drawing number 2, gives the standards pumping and electricity substation:

- The crane high tower (10),
- The pumping motors on the reservoir (11) and on top of the tower (13)
- The special pipe (12) from the reservoir to the tower pump (13),
- The long elastic light pipe (14) hanging from the tower (10),
- Pipes with preassembled pipes connection hub (9) along with flying platform (8) are laying down on the ground (15, 16).
- An electric power sub-station (17) gives electricity to all pumps and drones through the pipe (14) electric cable (18) carrier.
- Optionally for coastal fires a retired battle or commercial ship (19) with a tower on- board (10) is the absolute pumping station.

Drawing 3 gives the pipe connector and flying platform engineering details

- The base interconnection ring (21) with the pump coaxial fan inside.
- The elasticity and assembly ring (22)
- The motor that drives the coaxial pump (23)
- The on pipeline hanging ring (24)
- The drone hook (25)
- The drone structure (26)

- The drone motors and blades (28)
- The water sprinkle and water evacuation part (++)
- The electricity and data lines (27)

Drawing 4 describes an alternative inside the pipe booster (30).

The general functionality of the invention is very simple. The water is elevated from the basin (1) with the pumping station (2) through the long pipeline (3) and it ejects miles away from the pipeline endpoint (4) to the forest fire (5). The crucial difference is that the pipeline flies above the hills hanging from hundreds of drones (8). Optional balloons and heavy duty helicopters could be used.

On the reservoir (1) end, the water is pumped by a pump (11) up to the high tower pump (13). After this second flow enhancement pump the multi kilometers water journey starts through the hanging pipeline (14). There is a parallel electricity fetching system from the electricity substation (17) to the hanging line (18) an up to the end of the pipeline (4). The hanging pipe (18) is the initial part of the long pipeline. On the ground there is a number of long enough (for example 500 m) pipes (15,16). The first pipe (15) is connected to the hanging pipe (14). With a similar way all other type (16) pipes are connected accordingly on the ground up to the desired distance to travel.

During this installation the first airborne pipe (15) starts flying. Then the second and so on. A several kilometer flying pipe is travelling to the fire-point (5). The pumping station is pumping towards water to fill water in the pumps. At the moment the pipeline endpoint (4) reaches the fire area (5) the water is pressured at the maximum and flow reaches at the maximum.

We described above the land lake and dam pipe airborne feed water system. For coastal fires an old (19) could be equipped with the tower (10) and the perfect airborne pipeline system is ready. Any ship has all the other systems ready and cheap. Such a ship could cover the 80% of the fires in Greece.

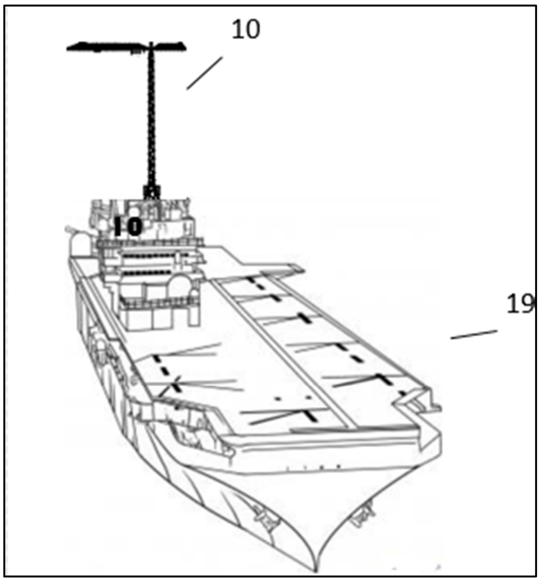

Figure 3. *Airborne and waterborn alltogether.*

Back to the main invention to deliver all these features the pipes are connected to each other with a double subsystem:

a) the pipe connector hub (9) which is hanging under
b) the flying platform (8).

The pipe connector hub (9) has four sides giving four different functions accordingly.

a) The first above side at the above endpoint a ring (24) is used to loosely be hanged from the flying platform (8) by the hook (25).
b) At the right and left sides of the connector hub (9) two pipelines are assembled. At both sides an intermediate elastic connector ring (22) is used to provide to the pipe some degree of free movement.
c) The forth down side hub part has a sprinkler for irrigation (29) and fire preventing applications.

The pipe connector hub (9) also provides electricity and routing data with a power and data cable (27) and it has a coaxial pump inside the inner ring (21) associated with an electric motor (23) providing manometer water head.

The above flying platform (8) has:

- a hook (25) from where the pipe connector hub is hanged,
- a structure (26) on top of which
- the drone elements (28) are installed providing elevation, travelling and guidance.

The main invention problem is safety in case of total pipeline or power failure. People or structures on the ground could be harmed. At this pre-engineering stage some extra security features has been added like:

- Automatic Mechanical and Electric disconnection of the two pipes.
- Parachute for smoothly landing of fail components.
- Small light battery to land safely in power failure
- Alarms to warn people on the ground.
- Water evacuation valve on the sprinkler valve.
- Carefully designed flying route avoiding cities and electricity earth lines.

At the engineering stage of the invention alpha test a number of parts will be replaced by more efficient subsystems A coaxial pump (23) could be replaced by a more sophisticated solution like (30) inner surface of the pipe trapezoid booster pump. All around the hub inner surface a small booster is installed (30). This booster pumps water downstream (31) and ejects it with higher velocity upstream (32). All these at the inner pipe surface. For more smoothly operation the booster is installed two cm in parallel of the inside surface of the pipe leading to a continuous pipe that is boosting at every inch of its length. (drawing 4)

Most the electric and mechanic parts are commercially available from the industry today but there are a lot of implementation details to be solved, both at a technical and cost benefit level.

3. Legal Description

Claim 1

The airborne pipeline (3) flies high above the ground to deliver water from a reservoir (1) through a pumping station (2) up-into the firefighting point (5) and it is characterized by consecutively inter connecting smaller pipes (15,16) assembled all together with the pipe connection hub (9), which is hanging from a flying platform (8).

Claim 2

The pipe connection hub (9), according to the above main claim, is characterized by downstream and upstream pipe connections main ring (21) through elastic assembly rings (22), electric and data supply cabling (27), a small optional coaxial booster pump (23) or an inside the inner surface of the pipe trapezoid booster pump (30), the sprinkler and evacuation valve (29) and the hanging ring (24).

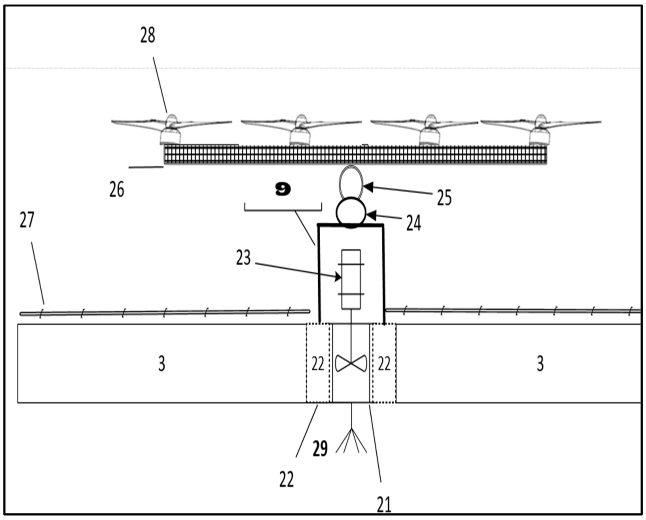

Figure 4. *Drone hangs pipe.*

Claim 3

The flying platform (8) according to the main claim is characterized by a hook (25) that hangs the associate pipe connection hub (9), a structure (26) and the drone motors blades and guidance (28).

Claim 4

The pumping station (2) according the main claim 1 is characterized by an electricity substation (17), two pumps (11,13), a high tower (10) to guide initially the first pipeline (14) while several pipes (15,16) ready with connection hubs (9) and flying platforms (8) are laying on the ground to be assembled manually.

Claim 5

The drone structure (26) in the above claim 3 is characterized [9] by its partially replacement for security and functionality reasons by a balloon (7) or a heavy helicopter (6).

Claim 6

The pumping station (2) in the above claim 4 is characterized by its totally replacement to decrease response time by a modified battle or commercial ship (19) having integrated by design construction all necessary pumping station features.

Claim 7

The pipes connection hub (9), and the flying platform (8) according the above claims 2 and 3 are characterized by a landing parachute, an emergency alarm and a small battery for safe landing after power failure.

Claim 8

The inside the inner surface of the pipe trapezoid booster pump (30) as described in the above claim 2 is characterized by smoothly operation with a small pump that inwards pumps water downstream along the pipe inner surface (31) and it delivers upstream (32) with increased velocity. The pipes (15) could have such a booster (30) as many as they need to achieve smoothly pipeline (3) operation.

4. Best Firepipe Mathematical Route

The airborne pipe has to fly over a specific route for various reasons like:

- Avoid people injure in case of air hanging failure.
- Avoid flying above or close to public utilities lines like electricity nad telephone cables.

For demonstration purposes I formulate a simple MATLAB program to calculate best route.

```
%MATLAB best secure route from point to point
from=input ('FROM' );
eos=input ('UP TO');
n = 15;
A = delsq(numgrid('H',n+1));
G = graph(A,'OmitSelfLoops');
G.Edges.Weight = ones(numedges(G),1);
h = plot(G);
path = shortestpath(G,from,eos);
highlight (h,path,'NodeColor','r','EdgeColor','g');
```

The calculated route from point 81 to 40 is:

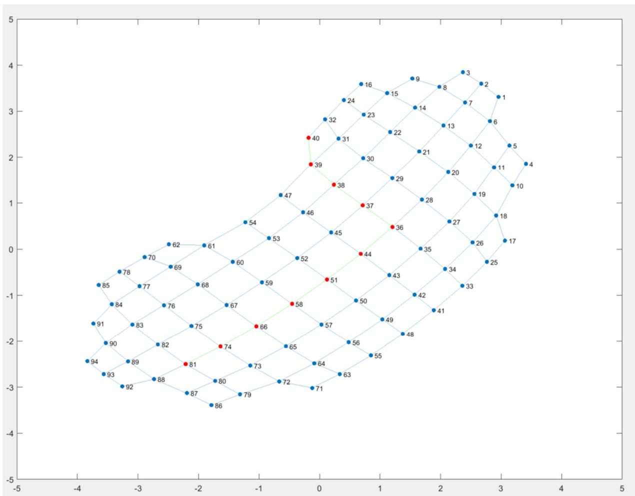

Figure 5. *The best airborne pipe route.*

5. Coaxial Pipe Inner Side Booster

Initially there was on strong pump in the beginning of a pipeline. Today we introduce the coaxial pipe inside booster [11, 12, 13]

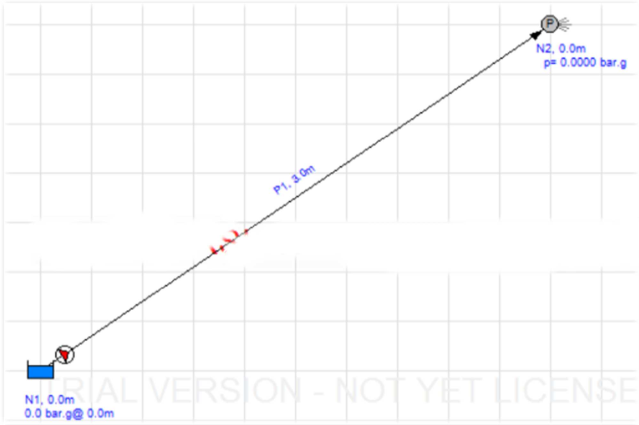

Figure 6. *The single pump pipeline.*

The cornerstone of the airborne system is the integrated pump in the pipe.

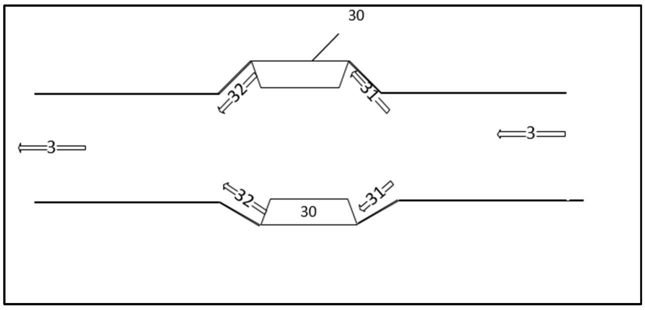

Figure 7. *Pump in a pipe concept.*

The design guidelines are:

- The inside diameter of the pipe is not affected in order not to eliminate the flow profile.
- The pump is enclosed in the pipe and reinforces the pipe durability.
- The flow operation is simple
- The downstream (31) enters the pump-booster (30)
- The booster offers kinematic energy
- The upstream gained velocity or head.
- Dynamic energy high upstream

$$\mathbf{K} = \frac{1}{2}\mathbf{m}v^2$$

- Kinetic Energy: Kinetic energy is the energy of motion. Energy is defined as the ability or capacity to perform work. The SI unit of kinetic energy is the joule.
- Mass: The quantity of matter in an object is known as mass. The greater the mass an object possesses the more kinetic energy it holds. Kinetic energy is directly proportional to mass. The kilogram is the SI unit of mass.

Velocity: Velocity is the rate of position change for an object. Kinetic energy is exponentially proportional to velocity.

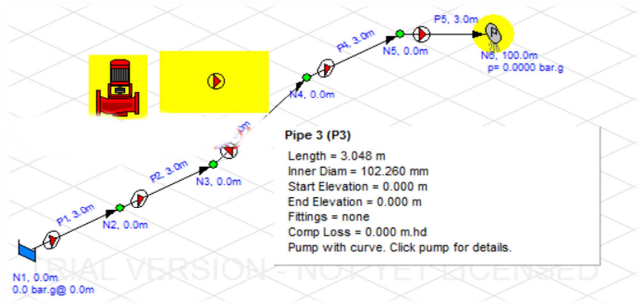

Figure 8. *A pump or pressure booster every meter.*

6. Conclusion and Recommendation

JEL Clasification

The airborne pipeline is not an academic exercise. It is a business opportunity for the environmental companies and it will follow the business guidelines in areas like:

- F18=Trade and Environment
- K32=Environmental, Health, and Safety Law
- O13=Economic Development: Agriculture; Natural Resources; Energy; Environment; Other Primary Products
- O44=Environment and Growth
- P28=Socialist Systems and Transitional Economies: Natural Resources; Energy; Environment
- Q00=Agricultural and Natural Resource Economics; Environmental and Ecological Economics: General
- Q15=Land Ownership and Tenure; Land Reform; Land Use; Irrigation; Agriculture and Environment
- Q50=Environmental Economics: General
- Q51=Valuation of Environmental Effects
- Q55=Environmental Economics: Technological Innovation
- Q56=Environment and Development; Environment and Trade; Sustainability; Environmental Accounts and Accounting; Environmental Equity; Population Growth
- R11=Regional Economic Activity: Growth, Development, Environmental Issues, and Changes

Pipe-Pipe implementation

The airborne pipeline is under pre-alpha test today waiting for the final European Patent Office approval. The implementation team has serious similar projects [13, 14, 15, 16]

However the coaxial pipe inner booster is a very innovative approach that is not limited to airborne pipeline use. Our ambitious are far to replace the traditional pump within unique smoothly operation.

Of course serious mathematical modelling is necessary before to proceed to the next pre alpha step (or test)

The system has serious irrigation applications but the firefighting challenge is more competitive, attractive and finally multi billion Euros business.

This paper is a part of an effort regional development and humanitarian actions to gain preferential business status at the implementation stage [17]

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