REVERSIBLE FERTIRRIGATION AND DRAINING SYSTEM BY INTRODUCING UNDERGROUND, WITHOUT DITCH PIPES

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In modern technology, the direct introduction, into the soil, of the underground pipes, without an open ditch for irrigation or draining represents a challenge in terms of connecting the irrigation or drainage systems to the water source or spillway. When the efficient drip irrigation system becomes reversible, capable to collect the excess humidity in the soil this idea becomes worthy of appreciation. Our suggestion is to extend the applications of the FORI 80 rocket for the reversible fertirrigation and respectively draining system, for which the underground pipe sections are introduced into the ground without open ditch at surface.

***Keywords**: pneumatic rocket, irrigation system, drainages, without ditch.*

In the construction of the irrigation and/or draining systems of advanced technology, specialists consider nowadays the necessity of simultaneously irrigating and fertilizing directly the reticular system of the plants both by drilling and by introducing water distribution and/or drainage underground pipes, without open ditch at surface.

The new, ecological, state-of-art technology is currently applied in the developed countries of the world. By importing the draining and/or irrigation equipment and producing the FORI 80 pneumatic rocket and the specific accessory kit –made in Romania, it has become operational in Romania too. Our proposal is to create dual, reversible drip irrigation and/or draining system, completely automatic, equipped with sensors and an integrated computerized system designed for data collection and processing, which is adjusted to maintain the optimal pre-established degree of humidity. The underground pipe system for water distribution and/or collection will be created in advanced technology, without ditch.

MATERIAL AND METHODS

The pneumatic rocket remains the basic component of the underground, without ditch pipe introduction system. This one may generate a micro tunnel and may simultaneously or separately pull the pipe inside the formed hollow.

The description and operation of the pneumatic rocket, including the modern technology of introducing and installing the underground, without ditch pipes has been presented [1].

Innovative technical solutions for doubling or tripling the weigh of the main piston generating percussions in order to increase the energetic self-propulsion percussion parameters of the pneumatic rocket have been proposed [2]. Material choice is essential in order to increase the rocket's penetration force into the soil and reach the energetic parameters achieved by the reference models created in the USA and Germany.

The duty cycle of the pneumatic rocket as a self-maintained percussion generator, without classical (compressed air) distributor, with mobile pieces in motion has been minutely detailed [3].

As technical novelty, the operationalization mode of the new technology has been proposed [4], using the FORI 80 pneumatic rocket and the specific accessory kit, as a product conceived and created for the first time in Romania.

A compared analysis of the known pneumatic high-speed cylinders, with automatic operating cycle for percussion generation, has been carried out[5].

The creation of an efficient stand for dynamic trials with real-time monitoring display of the analyzed phenomena has been proposed for the FORI 80 rocket [6].

Our suggestion is to extend the range of application of the FORI 80 rocket to create irrigation and/or draining systems, in an advanced technology, which eliminates the traditional open ditch, when introducing the underground pipes. As technological novelty, we present the complete technology and working equipment, which includes the pneumatic rocket and the accessory kit, as well as the irrigation and/or draining systems, completely automatic and adjusted to maintain the optimal pre-established humidity in the soil, regardless of the weather-climate regional-temporal conditions.

RESULTS AND DISCUSSIONS

2.1. Existing solution to introduce underground pipes

According to the classical technology, the underground pipes are introduced only in open ditch at surface. The underground pipes are mounted at soil level and the visible pipes are eliminated for the bed irrigation.

2.2. Proposed solution for the introduction of underground, without ditch pipes

The pneumatic rocket and the accessory kit for the introduction of underground pipes, without ditch, was the subject matter of the research contract [8] no. 43/1996 of SC MITECO SA from Iaşi. The *working equipment* includes: the pneumatic rocket and the accessory kit.The *pneumatic rocket* is a linear pneumatic motor with oscillatory, self-maintained motion of the main piston into the body of the rocket. The rocket (which is percussions motor generator) has an automatic duty cycle, and is compressed air supplied.The *accessory kit* includes: the energetic source (motor compressor), the launcher, the shooter, the expander and the device that couples and pulls the pipes into the micro-tunnel.

The *underground pipe introducing technology, without ditch,* has two operational stages:

- micro-tunnel generation;
- underground pipe pulling inside the micro-tunnel.

The two stages may be developed simultaneously or separately, depending on the case.

The introduction of the underground pipes without ditch, may begin only after the creation of the launching hole where the working equipment is placed (see fig. 2) [11], and respectively the exit hole, at the end of the lay-out, which may be located at maximum 150 m away from the starting point.

Figure 2. **FORI 80 pneumatic rocket with the accessory kit**

Both holes (the launching hole and exit hole) will be created at the required depth, which is pre-established at the starting point, as imposed for the introduction of the underground pipe. The recommended depth is below the freezing one for irrigation pipes or under 0,5 m for drainage pipes, from the maximum depth reached when tilling or when performing the mechanized maintenance operations of the cultures.

An air compressor which may constantly supply the optimal volume of compressed air (1 Nm^3/min) at an operation pressure of 8-10 bar functions as an energetic source. The pneumatic rocket is coupled to the air source (motor compressor) by air compressed designed flexible pipes. The pulling device for rigid pipe sections or draining flexible tubes is connected behind the rocket.

The device that pulls the rigid underground tubes allows a firm fastening of the pipe made of steel, cast iron, PVC, PP (polypropylene) or PE (polyethylene) behind the rocket. The specific pulling device for rigid underground pipe [11] is shown in Fig. 3.

Figure 3. **Coupling and pulling device for rigid pipes sections**

2.3 Advanced technical solutions for irrigation and draining systems

Our proposal regarding the construction of the irrigation system involves an integrated set of combined techniques: mechanical, pneumatic, hydro-technical and electronic techniques, which allow the installation of underground irrigating and/or draining systems, without an open ditch at surface, the distribution of the irrigation water, or the collection of the exceeding water for drainage, in a completely automatic manner, maintaining the optimal pre-established degree of humidity in the soil, regardless of the weather-climate, regional-temporal conditions and also the permanent control of soil temperature at the desired depth.

The *mechanical and pneumatic part* includes the FORI 80 rocket, the complete accessory kit and the energetic source (motor-compressor), involved in the generation of the micro-tunnel at the desired depth, inside of which the irrigation water pipe or the drainage perforated tube is introduced without an open ditch at surface according to the modern, ecologic and extremely efficient technology.

The *hydro-technical part* includes, as an element of technical novelty, the water distribution system for irrigations, which combines the radial arrangement advantages of the underground pipes towards terminals (underground hydrant type Dn 2"), out of which split flexible dripping tubes (fig. 4).

a) Irrigations with drip tubes **b) Drip tube – detail**

Figure 4. **Drip irrigations**

The tubes are placed at the surface, and they are perfectly adapted to water plants directly at the root, with ramifications in "n" desired directions. The tubes may be rolled in coils for re-positioning at various time intervals. The most efficient drip tubes in the world [13] are shown in fig. a, b, c.

a) Cylindrical dropper tube b) Flat dropper tube c) Irrigation band with dropper

Figure 5. **Drip irrigation tubes**

The drip irrigation technology uses controlled water quantities together with the water inhibition value of the soil and the evapotranspiration distributed directly to the plants' root. This system is particularly suitable for horticultural crops: field vegetables, solariums, greenhouses, vineyards, orchards but also flowers, corn and potatoes crops, this allowing a high mechanization degree.

Drip irrigation has introduced in modern culture the fertirrigation concept that is fertilization performed simultaneously with irrigation using the irrigation water as support. Fertilizers completely soluble in water which are perfectly adapted to drip irrigation installations are used to this effect. The soluble nutrients and the stimulating substances are administered simultaneously with the irrigation water in rigorously controlled quantities. In terms of costs, the administration of fertilizers amounts to 25%[12] of the classic fertilization cost. The drip irrigation system distributes water uniformly and slowly to close to the plants points, drop by drop, in a proportion and with a frequency adapted to the plants needs, facilitating the strict compensation of evapo-transpiration and allowing a rigorous control of the watering norms and their application. Water distribution to the radicular system of the plants leads to a reduced water consumption which represents only about 30% of the water consumption in spray irrigation and only 10-18% of the water consumption in bed irrigation, which implicitly leads to a reduction of the water supply costs. In comparison with other existing irrigation methods, this method ensures ideal biological conditions: the leaves and fruits are not watered, the pestilence and disease risk is reduced and the low air humidity eliminates the cryptogamous disease risk; the pesticides applied are not washed away when irrigating, their reaction time is prolonged and implicitly the number of treatments applied is reduced together with the substances used; the weed density and development as a result of the surface limited watering is also reduced.

Because of the slow capillary movement/motion of the water in the soil, the aeration of the soil remains constant and an appropriate respiration of the plants' roots takes place all through the vegetation season, without any fluctuations. Spray irrigation systems reengineering, does not involve the destruction of the old irrigation systems, but their significant re-use. Non-stop irrigation is possible even on extreme conditions for the slope soil also depending on soil permeability conditions and plants demands.

The peripheral water losses are completely eliminated (adjacent roads, soils and end areas watering). Soil temperature should be kept higher than for the spray and bed irrigation during watering, this fact leading to an earlier maturity of the cultures which is highly important for the irrigation of the protected spaces (solarium, greenhouses). The drip irrigation systems use low pressure on the main system (only 0,3- 1,05 atm.), as compared with the spray irrigations where the working pressures are higher. The power consumption is diminished and the safe operation of the feeding network increases.

Water circulation reversal with the modification of the dropper in order to increase the intake capacity by widening the free spaces in the dropper mass makes the tube reversible and thus, it can be used for draining in order to fight the excess

humidity in the soil. The evacuation conditions for the water collected/drained through the system should obviously be ensured at the outlet.

This system represents a significant economy in terms of labor force and effort since the handworks performed in order to move the mobile irrigation system for the spray irrigation or in order to form and maintain the furrows are eliminated and only security and protection workers are required (only 7% of the labor force used for spray irrigation and approximately 2% of the labor force used for bed irrigation).

The system features some insignificant deficiencies:

- the specific investment cost which is a little more expensive but quite rapidly redeemable (1-2 years) since the production cost is reduced , the production and product quality increase.

- the possibility of having the equipment on the field (taps, filters, drip tube) damaged by malefactors or stolen, the value of the possible damages being however smaller than for the bed or spray irrigation equipments.

The *electronic part* includes a complete set of sensors with digital display, used to detect, control and correct the humidity/temperature of the soil, or the water pressure inside the pipes, in a totally automatic manner.

The *computerized part* includes several basic components: PC unit with interactive software to monitor the technical parameters that may be programmed or visualized on digital display or printed, PC/sensor interface modules, integrated within the computerized system, which is compatible and used, and the data acquisition device, which modulates the sensor electric signal in PC video signal.

ADVANTAGES

This technology for the introduction of underground pipes without ditch, by means of the proposed pneumatic rocket, offers a set of advantages that are clearly superior to classic technologies, with an open ditch, currently applied in Romania, in that several expensive operations such as: digging, bank reinforcement, filling, filling compacting, etc are eliminated.

The new technology is ecological, efficient, and it does not disturb the normal development of surface activities, in the under crossed area.

The drip irrigation system is superior to the classical spray or bed irrigation systems: reduced price per linear meter, increased productivity of the cultures; better quality production; water and power saving; fertilizers and chemical treatments saving; less weeds in the culture area and avoidance of the compact soil formation; dry field between the plant beds ensuring the permanent access to the cultivated field.

CONCLUSIONS

The “key” element that makes the structural difference between the classical technology used for the irrigation or draining installations creation, known in the

specialized literature [7], and the new proposed technology is the introduction of underground pipes, without open ditch.

The constructive simplicity of direct introduction into the ground of water distribution or collection pipes, as well as its efficient dispersion in drips directly at the root of the plants, is a genuine element within the current technical environment applied in Romania, as it may be used to fight draught (by irrigations), or to eliminate excessive soil humidity (by drainage).

BIBLIOGRAPHY

1. Postgraduate Eng. Claudia Tănase, Dr. Eng. V. Neculăiasa, Contributions for the Promotion of New Ecological Technologies to Introduce Underground Pipes, Without Ditch. Scientific paper, "Gh. Asachi" Technical University of Iasi, July 2006.
2. Postgraduate Eng. Claudia Tănase, Dr. Eng. V. Neculăiasa, New Super Heavy Materials Used in Construction Engineering, with Major Energetic Impact over the Piston Striking the Pneumatic Rocket Introducing Underground Pipes Without Ditch. Scientific paper, University from Bacău, August 2006.
3. Postgraduate Eng. Claudia Tănase, Dr. Eng. V. Neculăiasa, Contributions for the Elaboration of Pneumatic Rockets Introducing Underground Pipes Without Ditch. Scientific paper, "Gh. Asachi" Technical University of Iasi, January 2007.
4. Postgraduate Eng. Claudia Tănase, Dr. Eng. V. Neculăiasa, Contributions for the Operationalization of Modern Technologies with Equipment Manufactured in Romania for the Introduction of Underground Pipes Without Ditch. Scientific paper, "Gh. Asachi" Technical University of Iasi, January.
5. Postgraduate Eng. Claudia Tănase, Dr. Eng. V. Neculăiasa Contributions for the Elaboration of the Accessory Kit of the FORI 80 Pneumatic Rocket Introducing Underground Pipes Without Ditch. Scientific paper, "Gh. Asachi" Technical University of Iasi, April 2007.
6. Postgraduate Eng. Claudia Tănase, Dr. Eng. V. Neculăiasa Stand for Dynamic Trials of the FORI 80 Pneumatic Rocket Introducing Underground Pipes Without Ditch. Scientific paper, "Gh. Asachi" Technical University of Iasi, June 2007.
7. V. Blidaru Irrigation and Draining Devices, Interprint Publishing House, Bucharest 1997.
8. *** Research Contract no. 43/1996 of SC MITECO SA Iaşi for the elaboration of self-propelling combines, by percussion, to introduce underground pipes without ditch.
9. *** Research contract no. 43/1996 of SC MITECO SA Iasi regarding the production of the self propelled harvesters by percussion for the introduction of the underground without ditch pipes.
10. *** Company Prospects ProAqua.
11. *** Company Prospects - Vermeer (USA).
12. *** Company Prospects - Tracto-Technik (Germania).
12. *** Aqua-Traxx Italia (SUA license).
13. *** Relian SA - Toro Ag.