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A Way to Enhance Hail Prevention Technique and to Increase the Efficiency of Anti-Hail Protection of Unlimited Agricultural Areas

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Abstract

In this article a new method and a station of anti-hail protection are described based on the early prevention of hail formation by significant shock waves, enriched by silver iodide or other reagents, allowing implement fully autonomous and automotive anti-hail protection of rural and urban areas of any size, restricted or unrestricted.

Introduction

Despite the best efforts of the authorities, farmers and researchers the protection of rural and urban areas from hail remains an actual problem for all countries subject to hailstorm, since every year, hail continues to cause irretrievable, great and severe damage to agriculture, rural and urban vegetation and properties, both, civil and state. To suppress hail power and to reduce damage from hail in agriculture and in the economy it is necessary to use anti-hail protection methods and stations that will be more efficient in application and chip in exploitation. At present the anti-hail protection of width areas is implemented by the following methods: seeding of clouds with silver iodide or other substances, which induce freezing to occur at warmer temperatures than otherwise, and the use of sonic cannons (gas-generators) or other kinds of explosive devices, which involves supersonic and significant shock waves generation and their direction upwardly to the sky, to transports positive ions from ground level to cloud level which disrupt formation of hail nuclei. Both described techniques are not efficient against already formed hailstones, so the most important requirement in their application remains their timely startup. A developed method of hail generative clouds early detection, based on the measuring of clouds intrinsic emission in radiofrequencies [1-10], allows interrupt hail formation in cumulonimbus and to implement fully autonomous and automotive anti-hail protection of any areas of any size. However, to increase efficiency of protection against hail, it is advisable to combine sometimes two described methods, and to enrich the ground level by reagents, which will then be moved to cloud level by shock waves. In this presentation will be described a new method and a station of anti-hail protection based on the early prevention of hail formation by significant shock waves, enriched by silver iodide or other reagents, allowing implement fully autonomous and automotive anti-hail protection of rural and urban areas of any size, restricted or unrestricted.

Clouds seeding by shock waves for hail prevention

In Figure 1 an option from [3] for implementation of fully autonomous and automatically functioning large-scale network of anti-hail protection is presented allowing to protect a vast (practically unrestricted) area (1) comprising M>>1 spatially distributed protected sites (2) 50-70 hectares each and hail trapping areas (2T). Each protected site (2) and hail trapping area (2T) is equipped with an anti-hail protection system (4) comprising a powerful supersonic cannon (gas-generator) and a local detector-alerter for early detection of impending hail or hail generative clouds, by measuring apparent temperature of the corresponding part of the sky just over the protected site or hail trapping area, and for timely starting-up the corresponding site's and trapping area's gas-generators (supersonic cannons). Detailed block diagrams of the corresponding site's anti-hail protection system including a local detector-alerter and a gas-generator and initially described in [4-10] are presented in Figure 2.

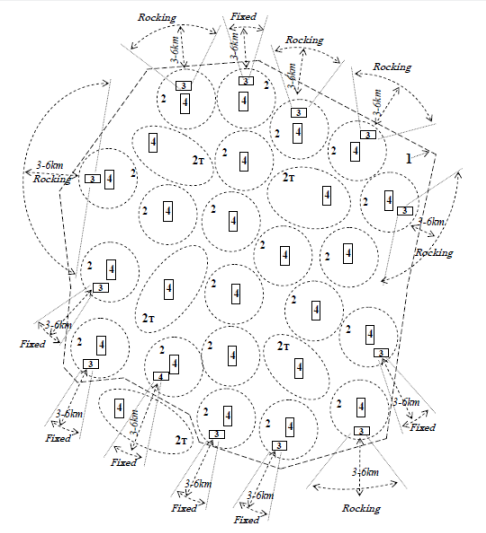

Figure 1: An outline of a version of large-scale anti-hail protection network

1 – a protected area, 2 – a protected site, 2T – a trapping area, 3 – a far-range detector-alerter with a scanner if necessary, 4 – an anti-hail protection system comprising a local detector alerter and a supersonic cannon (gas-generator).

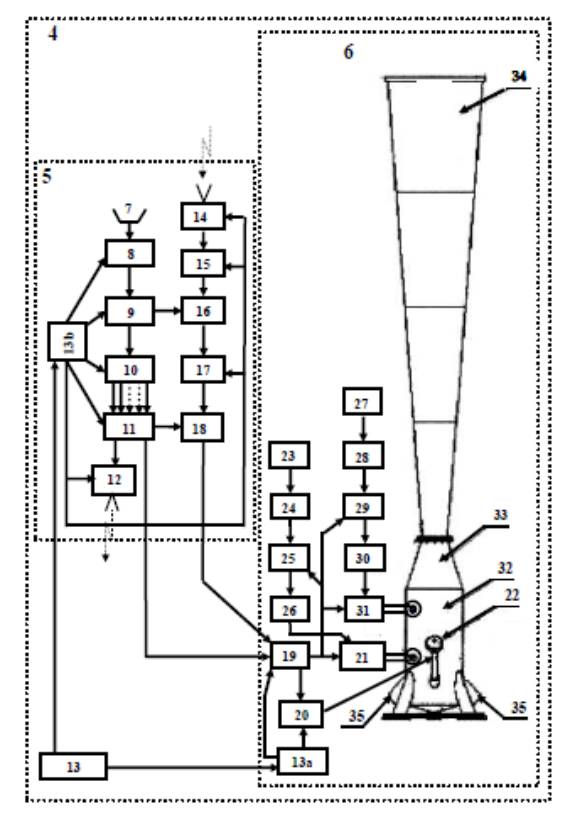

Figure 2: A block diagram of an anti-hail protection system

3 – an anti-hail protection system, 5 - a local detector-alerter, 6 - a sonic generator, 7 – an antenna, 8 – a radiometric receiver, 9 – a compensation device, 10 – a multi-channel thresholder, 11 – a warning device, 12 – a transmitter, 13 (13a and 13b) – a power supply, 14 – a receiver, 15 – a code comparator, 16 - the first controlled switcher, 17 – a single-channel thresholder, 18 - the second controlled switcher, 19 – a controller, 20 – an ignition means, 21 – a fuel injector, 22 – an igniter, 23 - a fuel reservoir, 24 – a mechanical valve, 25 – a solenoid valve, 26 – a pressure regulator for a fuel, 27 - a reagent reservoir, 28 – a mechanical valve for a reagent, 29 – a solenoid valve for a reagent, 30 – a pressure regulator for a reagent, 31 – a reagent injector-mixer, 32 – a cylindrical combustion chamber, 33 – a neck, 34 – a conical barrel, 35 – inlet ports

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The marginal sites of the protected area (1) in addition are equipped with a remote sensing complex of K far-detection (far-ranging) systems (3) spatially distributed along the edges of the protected area as shown in Figure 1. The remote sensing complex which serves the whole protected area (1) of M sites is used for far-ranging detection of hail or hail generative clouds over an adjacent land all around the protected area at a horizontal distance 4-6km far from the edge (boundary) of the protected area (1) and at the altitude 3-5km, as well as for warning the anti-hail protection systems of the protected sites of the protected area (1) by transmitting on the air the warning signals on impending hail danger from a certain adjacent land of the protected area of M sites. The number K depends on the type of spatial distribution of M sites and it can have a value from the interval [1⍰M], e.g. if M sites are spatially distributed around a common center it will be possible to use only one (K=1) far detection system. If all M sites are located far apart as a long chain then for entire serving the protected area of M sites it will be necessary to use K=M far detection systems. Depending on the terrain relief, any of the far detection systems can be installed individually, near or at a distance from the corresponding detector-alerter, inside or outside the corresponding protection site, etc. Further actions of the chain are described in detail in [2,3]. A detailed block diagram of the far detection system is presented in [1-10].

When M=K=1 the option of Figure 1 is performed into the outline of a version of implementation of a local network of autonomous and automatically functioning anti-hail protection of the protected site (2) of a limited size, including a restricted area like one of the marginal sites of Figure 1 and one or more trapping areas (2T) [1]. Operation actions of the local network of an anti-hail protection of a locally restricted area are described in detail in [1]. Sometimes, some of marginal gas-generators of Figure 1 and gas-generators of the trapping areas can be equipped in addition by reagent injecting facilities, which can enhance hail trapping and can make hail to fall out in trapping areas and thereby quickly neutralize hail threat. A block diagram of the anti-hail protection system (4) including the local detector-alerter and the gas-generator with reagent injecting facilities is presented in Figure 2.

When the far-range detector-alerter of any azimuth direction detects hail cloud or cumulonimbus coming from certain azimuth direction it warns detector-alerters of nearby located protected sites. Simultaneously it warns as well detector-alerters of the relevant trapping areas (2T) by transmitting on the air warning code-signals about impending hail danger from the certain direction. In a case if the far-range detector-alerter detects a cloud of severe hail the detector-alerters of nearby located protected sites turn-off their gas-generators to skip impending hail cloud. In opposite, the detector-alerters of the relevant trapping areas set the "alert mode" of operation for their gas-generators and start-up their gas-generators when the signals of sky brightness temperature (apparent temperatures) exceed the "alert" threshold level. Detector-alerters of the involved trapping areas turn-off their gas-generators when the corresponding far-range detector-alerters interrupt transmitting warning code signals on impending hail danger and when the levels of the signals of sky intrinsic microwave emission measured by their detector-alerters fall below the "alert" thresholds levels. During the first few explosions, a reagent is injected into the combustion chamber of the gas-generator, which, as a result of an explosion leaves the combustion chamber through the conical barrel of the gas generator and enriching the ground level of the air with microscopic particles After that, due to the successions of significant shock waves the particles of the injected reagent, together with existed in the air positive ions are transported from ground level to cloud level. So, by this way it is possible to increase the probability of disruption of formation of hail nuclei and to implement fully autonomous and automatic trapping of hail and to enhance protection possibilities of the above described networks of locally restricted and wide-ranging anti-hail protections.

Conclusion

Despite the fact that joint application of reagents and shock waves can increase the cost of anti-hail protection and pollution level of agricultural fields and environment, however the combination of both techniques clouds seeding by reagents and impact on clouds by generated and directed upwardly to the sky supersonic and significant shock waves can enhance the probability of hail prevention and hail suppression.

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