

CHARACTERISTICS OF SILVER IODIDE ICE NUCLEI GENERATORS
CURRENTLY USED BY SO.R.E.M.

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In this paper are exposed some technical and operational characteristics of two advanced types of ground-based AgI-generators, developed and utilized at the present in Italy for both rain-enhancement and hail-prevention campaigns. The first one (S11 type) is particularly intended for the operation from a fixed station. It is very rugged and reliable tool, and can be operated by unskilled people.

The second one (type GM 10) is conceived specially for mobile operation. It is trailer-mounted and equipped for travelling stations which are connected with the operative centre by radio-link, and directed through radar-echo observations.

S11 TYPE GENERATOR (patented)

The S11 unit is an AgI ice nuclei generator representing the target point of a long research work meant to obtain in the field of stationary generators an optimum combination of such characteristics as:

1. Max. efficiency R (active nuclei per gram of AgI used)
2. Max. hourly output capacity D (production of active nuclei per hour of operation)
3. Utmost reliability in operation continuity
4. Simplicity of operation and maintenance

The diagram shown in Figure 1 will provide a clearer understanding of its operation principle.

The propane gas bottle, fitted with a cock, is connected through a pressure reducer, to both the burner and tank containing the AgI solution.

The pressurized solution reaches the spray nozzle which atomizes it into a steel elbow heated by the burner action to red-hot temperature.

At this stage the combustible part of the solution ignites thus contributing to reach the optimum temperature for the AgI evaporation and following sublimation which will then give place to the formation of active ice nuclei.

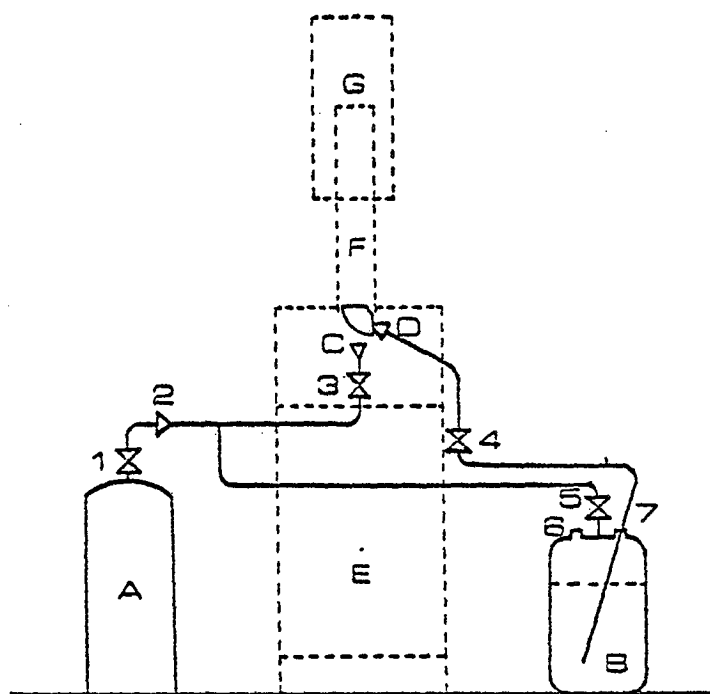


Fig. 1 - Generator type S11

- A - propane gas bottle
- B - AgI solution tank
- C - burner
- D - spray nozzle
- E - steel construction
- F - G - chimney
- 1 - 3 - 4 - 5 - operating valves
- 2 - pressure regulator
- 6 - filler
- 7 - suction pipe

The operational parameters adopted for the S11 generator are the following:

Propane gas pressure: 1 atm
AgI solution consumption: 2 liters/hour
AgI contents in the solution: 10.5 gr/litre
Max running duration: 13 hours

The average efficiency (R) and the consequent average output capacity (D) related to the above values for activation temperatures between -10 and -21°C, are shown in Fig. 2.

The efficiency curve has been obtained by averaging numerous measurements effected for activation temperatures of -10, -15 and -21°C and is completed, in coincidence with these points, with the values of its relative mean square root (or standard deviation).

From this curve, for example, it appears that the R value at -10°C is very close to 10^{14} active nuclei per gram of AgI used (for accuracy's sake $9.79 \times 10^{13} \pm 3.69 \times 10^{13}$) and, since, with the operational parameters referred to above, the AgI hourly consumption is 21 gr., the average hourly output capacity at that temperature (D_{-10°C}) is 2.05×10^{15} active nuclei per hour (upper curve of fig. 2).

At -15°C the average efficiency is 8.39×10^{14} active nuclei per gram of AgI and the consequent output capacity value is 1.76×10^{16} nuclei per hour.

At -21°C the relative values show a further increase, the average efficiency being 2.2×10^{15} nuclei per gram of AgI and the output capacity 4.62×10^{16} nuclei per hour.

Since the generator efficiency is also closely tied to the geometry of the burner elbow spray nozzle assembly, special constructional features have been adopted to prevent said geometry from being fouled during the assembling stage and to maintain it unaltered when the unit is being normally operated.

In the choice of the material used, due consideration has been given to the high corrosive action of the AgI solution. Accordingly, all parts in contact with this solution are made from stainless steel or other inert or anti-corrosive material.

GM-10 TYPE GENERATOR

The GM-10 type is a AgI nuclei generator whose main characteristic is high hourly output capacity. Being a trailer-mounted unit, it allows a considerable flexibility of operation.

Fig. 3 gives an outline of its various component connection.

$\bar{D}$ nuclei/hour
 $\bar{R}$ nuclei/AgI gram

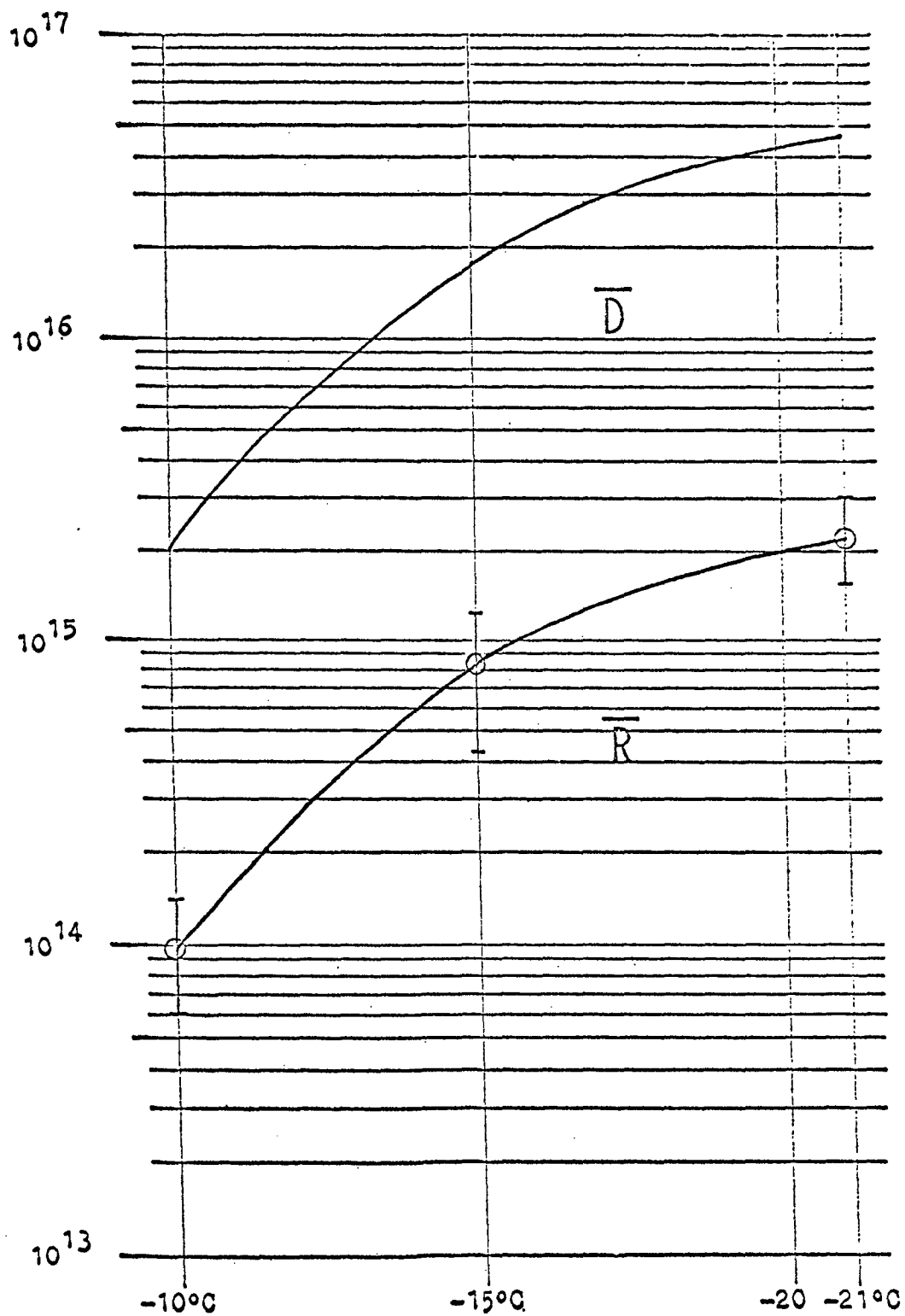


Fig. 2 - Characteristics of the generator type S11

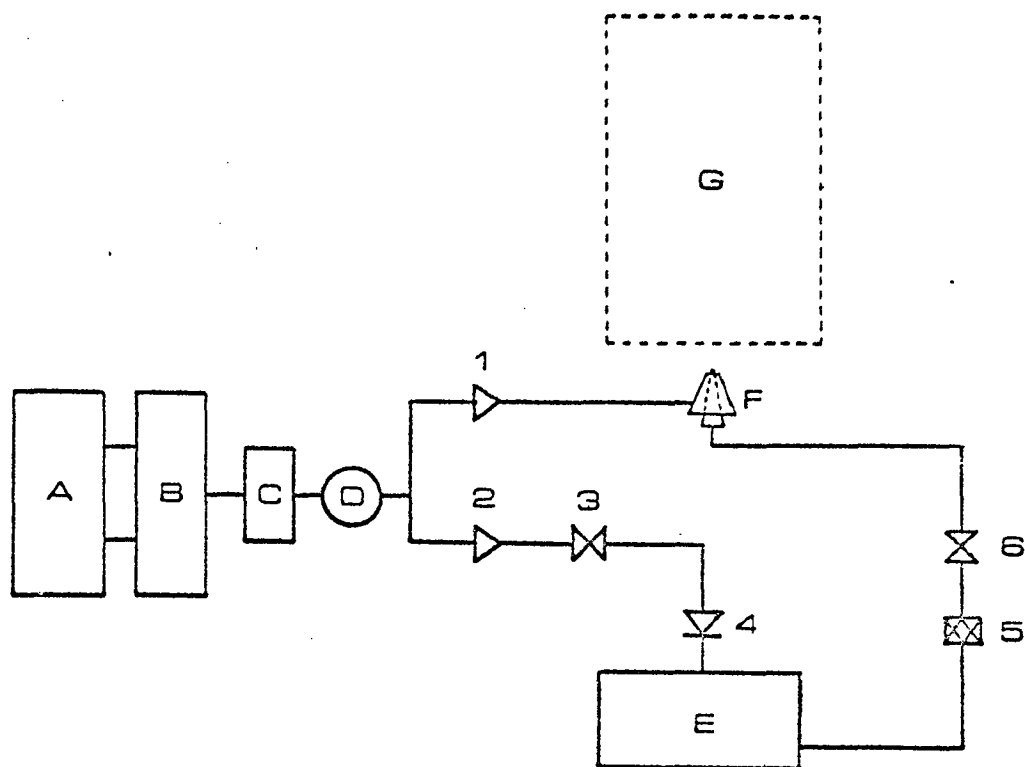


Fig. 3 - Generator type GM10

- A - gasoline engine
- B - compressor
- C - dynamic air cleaner
- D - air filter
- E - AgI solution tank
- F - dual (air-solution) nozzle
- G - chimney
- 1 - 2 - pressure regulator
- 3 - 6 - operating valves
- 4 - check valve
- 5 - solution filter

The engine-actuated compressor provides the necessary compressed air which, after depuration through a double-stage filtering system, reaches the pressure regulators 1 and 2.

From the first regulator the compressed air, after reduction to the required pressure value, reaches the air section of the two-fluid type spray nozzle from which is violently ejected.

From the second pressure regulator, the compressed air, duly reduced to the pressure required for the relative circuit branch, reaches, through an operating cock and a check valve, the tank containing the AgI solution, which becomes pressurized to a determined value.

Subjected to this action, the AgI pressurized solution is forced through the solution filter and the operating cock and reaches the liquid section of the AgI spray nozzle at the exit of which is atomized by the compressed air jet referred to above.

Finally, at this stage, the solution combustible part ignites thus causing the AgI evaporation and following sublimation which will in turn give place to the ice nuclei formation.

The optimum operational parameters of the GM-10 generator have been found to be the following:

- Pressure of the AgI solution = 0.2 atm
- Pressure air atomizer = 1.6 atm
- AgI solution consumption = 10 litres/h
- Running duration = 10 hours

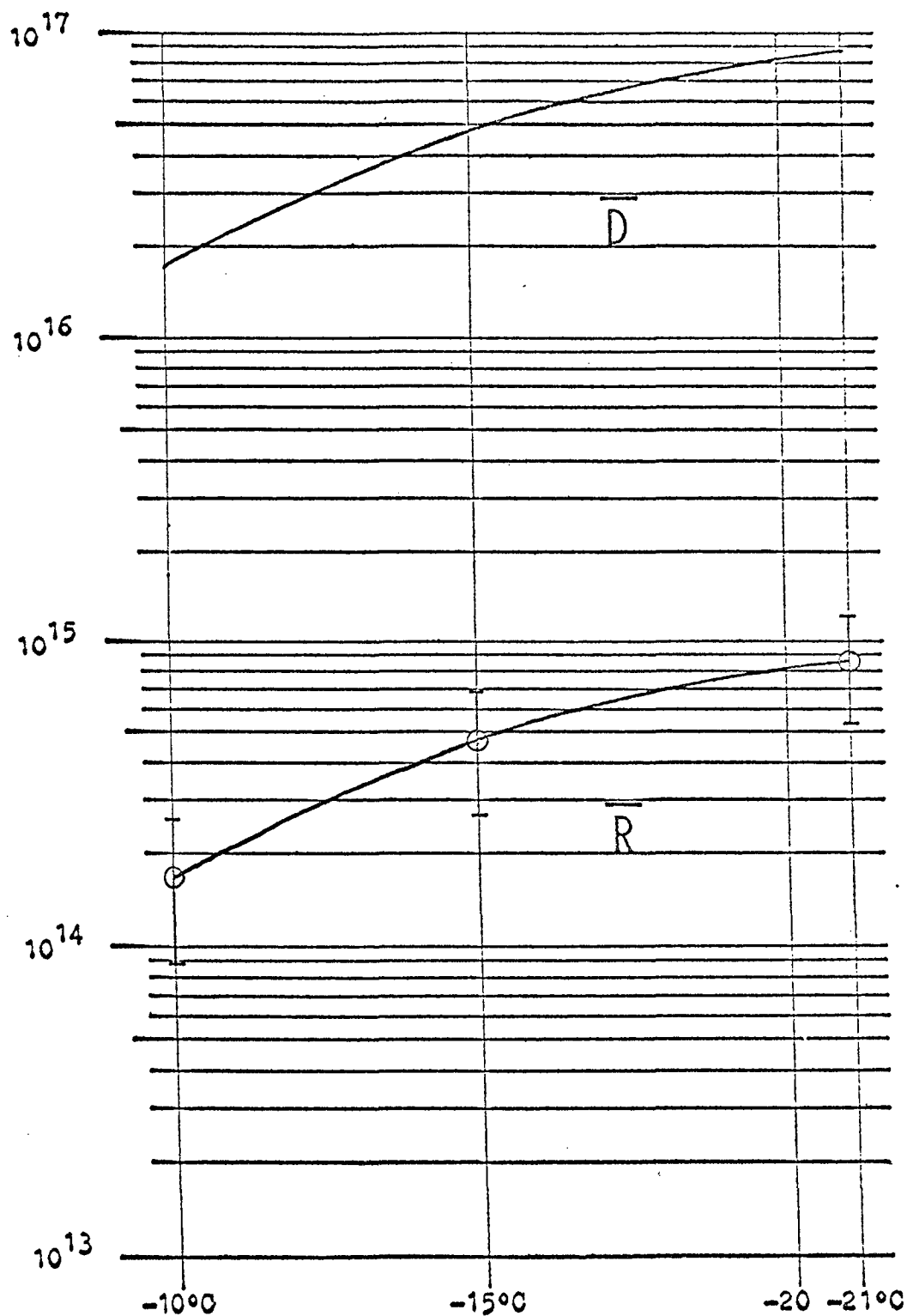
With the above operational parameters the GM-10 generator proves to be a unit of exceptionally high efficiency and hourly output capacity. The relative diagrams are shown in Figure 4.

The average efficiency at temperatures of -10°C , -15°C , and -21°C is respectively 1.55×10^{-14} ; 4.68×10^{-14} ; and 8.45×10^{-14} active nuclei per gram of AgI; the hourly capacity reaches, to the same temperatures, 1.63×10^{16} ; 4.91×10^{16} and 8.87×10^{16} active nuclei respectively per operating hour.

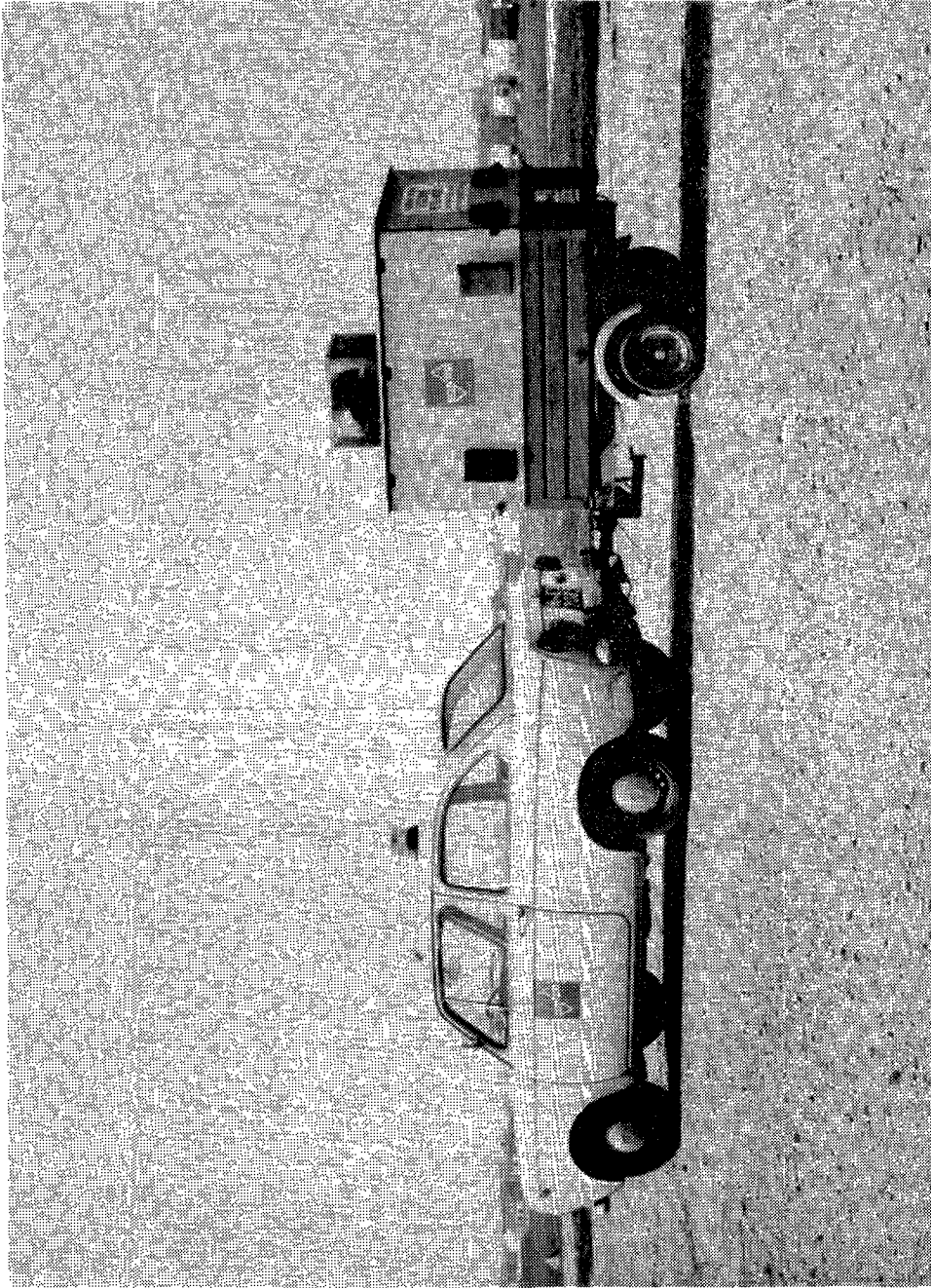
Because of its capacity to operate during displacement travels and being characterized by a quite notable output capacity, the GM-10 generator finds its best utilization along windward routes with respect to the area to be seeded.

The GM-10 generator reliability in operation continuity is ensured, apart from the quality of its components, also by the simplicity of its operation arrangement which in itself is the result of numerous experiments and long experience.

$\bar{D}$ nuclei/hour
 $\bar{R}$ nuclei/AgI gram



Temperature
 Fig. 4 - Characteristics of the generator type GM10



SO.R.E.M. - Generator type GM10