THE HISTORY AND TECHNOLOGY OF MAN-MADE SNOW IN WINTER RECREATION AREAS

PART II - APPLICATION AND ECONOMICS

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Introduction

During the summer and fall, most people believe ski areas are inactive. Actually, much is being done to prepare for the next ski season.

Not only is preventative maintenance performed, but new construction also takes place on the mountains. Old chairlift unloading platforms are replaced or rebuilt; concrete counterweights refurbished; and new lifts and terminals are constructed, with most of the material being air lifted (Fig. 1).

Conditioning of trails is also important to maximize every inch of snow that falls. Existing trails are blasted and widened, while new trails are cut and cleared. Even trail signs need repair, thanks to the porcupine family (Fig. 2). This continuing effort is all in preparation for that first foot of snow which beckons skiers all across the country to their favorite ski slopes. Forests and mountains (Fig. 3) soon provide spectacular settings for the first skiers of the season (Fig. 4).

But, suppose there is insufficient snow cover to ski on or, even worse, no snow at all? This is where modern snowmaking steps in.

As mentioned in the previous paper, by Walsh, man-made snow is real snow, and the production of this snow is accomplished through two different techniques: (a) the compressed air methods, and (b) the mechanical or "airless" method. First we will discuss the compressed air method. What are the basic components of any snow-making system? (Plate I).

1. An adequate supply of clean cold water - lake, pond or stream.
2. High head pumps. Vertical turbine (Fig. 5) or split case multi-stage horizontal centrifugal (Fig. 6).
3. Compressed Air. Stationary electric (Fig. 7) or portable diesel (Fig. 8).
4. Distribution Systems of aluminum or steel pipe, with welded or mechanically coupled joints.
5. Modern snowguns (Fig. 9) and high pressure hose.

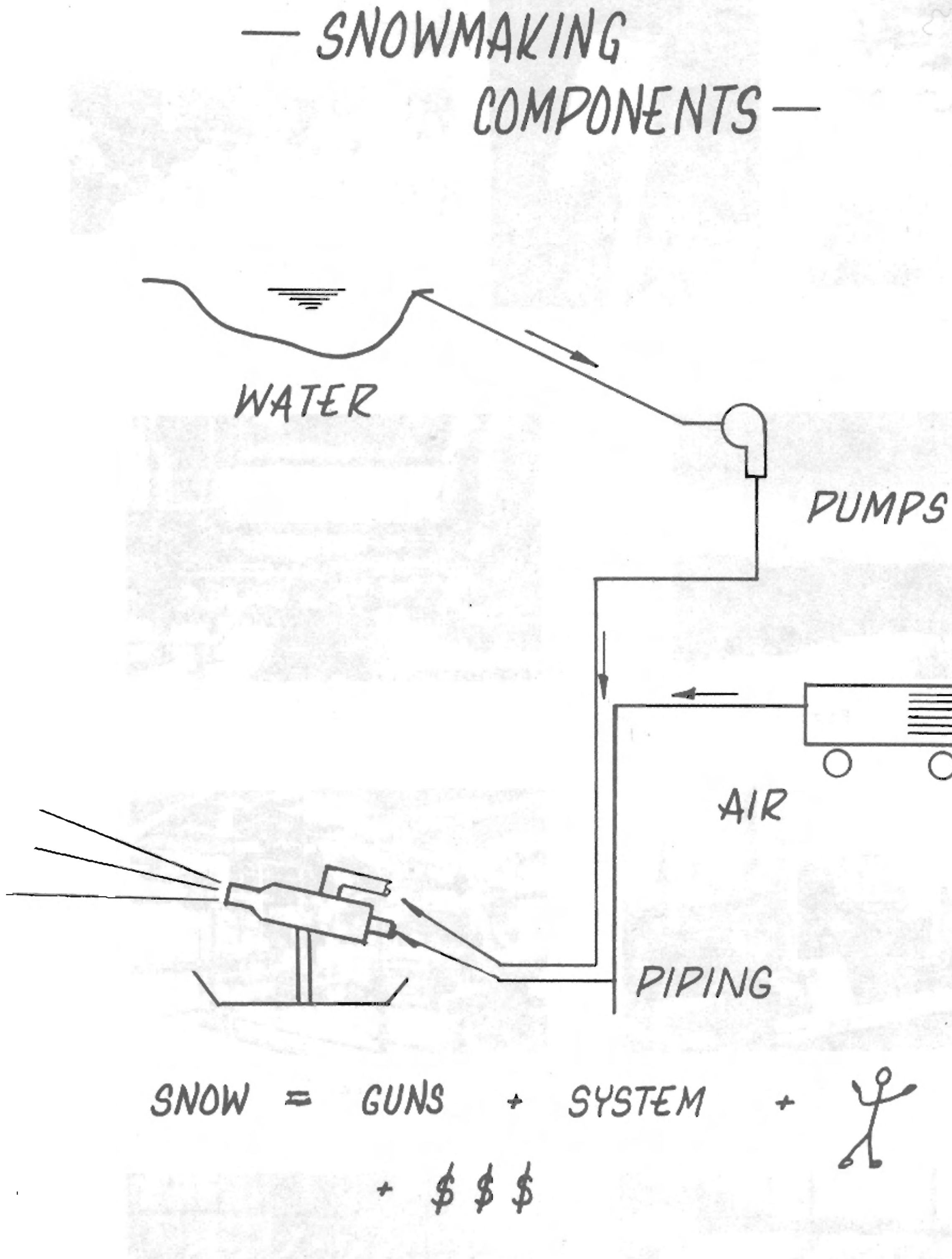
— SNOWMAKING
COMPONENTS —
WATER
PUMPS
AIR
PIPING
SNOW = GUNS + SYSTEM +
+ $ $ $

PLATE I

Fig. 1

Fig. 2

Fig. 3

Fig. 4

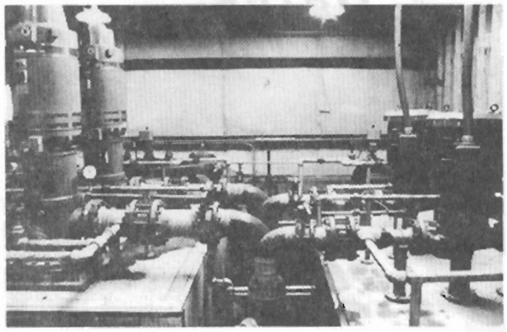

Fig. 5

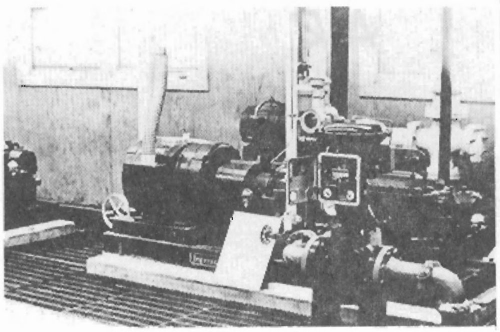

Fig. 6

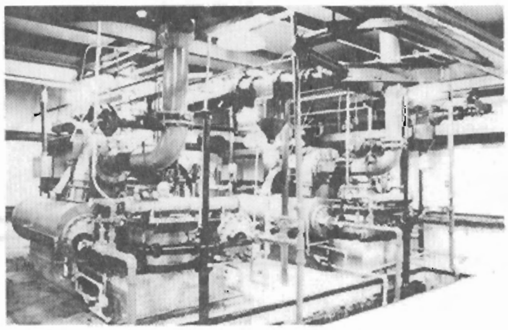

Fig. 7

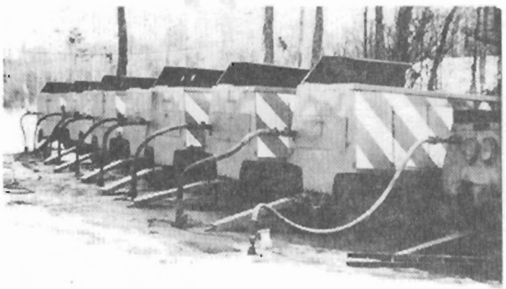

Fig. 8

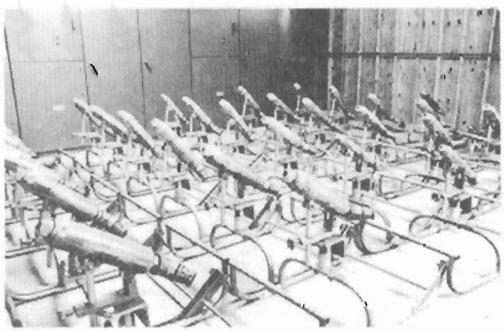

Fig. 9

6. Skilled and semi-skilled labor - many ski areas make a costly mistake in this category by either paying too little or being indifferent to the type of person hired.

Discussion

1. Without an adequate supply of water, maximum use and efficiency of any snow-making system will not be realized. Although it is difficult to arrive at a precise amount of water required, reliable test data on snowgun performance can assist in arriving at figures that are meaningful (± 10%). The controlling parameter in determining water requirements is the "maximum conversion capability" of the system at low temperatures (less than 10°). There are several reasons for this: (1) the colder the temperature, the less air is necessary to assist in water conversion into snow, (2) January is usually the coldest month in most northern hemisphere ski areas and is, consequently, the time when the snow-making process is most efficient, and (3) it is also the time when streams freeze shut and lake ice reduces useful storage. Stream gagings, hydrologic studies and a sound operating philosophy can yield very meaningful water supply requirements. It isn't unusual for larger ski areas to use over 50-million gallons of water during a ski season for manufacturing snow.

2. Although there are two basic methods of supplying water to the most elevated points in a snow-making system, gravity and pumping, the latter is by far the most prevalent. Very few areas are blessed with high elevation natural ponds that contain sufficient water to supply the system. Vertical turbine and multi-stage centrifugal pumps are both favored by the industry either as single high head pumps or used as boosters in relay stations. Total dynamic heads (TDH) in excess of 1000 feet aren't unusual.

3. Determination of the quantity of compressed air (100 psig) necessary for a given system is much more difficult than sizing a water supply system. Some factors which enter into the final decision are (1) operational philosophy of the area, (2) budgetary controls, (3) space availability, and (4) the cost of power, either fuel oil or electricity.

   Maximum air consumption normally occurs in the early weeks of operation (mid-November to Christmas). This is due to relatively high temperatures and the desire to produce snow as fast as possible to allow for early opening of the facilities. There are currently four types of air compressors being used by the ski industry: portable diesel, stationary electric, jet turbine and gas portable turbine. However, electric and diesel compressors provide nearly all the air used by the snowmakers today. The total air capacity of various ski area systems ranges from 1200 cfm up through 39,000 cfm.

4. When snowmaking was in its infancy, almost all distribution piping was aluminum and installed above ground. Although this type system was economical and convenient, it also had inherent drawbacks, the greatest of which was freezing. Now,

except for very unusual situations, steel piping is employed and installed below grade whenever possible. Mechanical joints allow easier assembly and greater flexibility, although some suppliers do provide for welded connections.

5. Perhaps the most controversial single topic in the snow-making industry is directly related to the use of "snowguns" or snow-making "nozzles." At cold temperatures (less than 10°) snow can literally be made with a straight piece of pipe, although it may not be very efficient. However, modern snowguns are extremely sophisticated and engineered. Individual air capacities range from 150 cfm to 1500 cfm which, on cold days, can convert from 30 to 350 gpm into snow. Prices run from $125 through $6,000 for each unit. The larger "guns" are sometimes provided with water-operated winches or trailers to assist in mobility.

6. Compared to all other jobs involved in operating a modern ski area, making snow has to be the least appreciated and most frustrating of all. Working conditions are difficult at best. But, in spite of the negative aspects of the assignment, there are still people interested in doing this type of work. Considering the total cost of operation, salaries or wages for key personnel should be as generous as possible. In addition, these same people should be encouraged to visit other areas, trade shows, and live demonstrations to increase not only their technical competence, but also to maintain a high level of enthusiasm for the job.

AIRLESS SNOWMAKING

Obviously, the major difference between air/water and "airless" snowmaking is the absence of compressed air. The water is mechanically atomized (Figs. 10 and 11) at a considerable savings in power costs. Water supply, pumps, distribution system and labor requirements are essentially the same for both systems. There is an additional savings if gasoline-driven units are operated as opposed to electric. The cost of power distribution can then be eliminated.

Water capacities of these units run from 30 gpm upwards to 1000 Costs also vary a great deal from $3,000 to $60,000 per unit. The smaller snowmakers can be boom-mounted while the larger require snow-grooming vehicles to provide their mobility.

SNOWMAKING DESIGN

Let us follow a simplified design procedure for an air/water snow-making system (see Plates II through IV). It should be noted in Plate II, Item F, that if the air water ratio necessary were reduced to 10:1, only one half the air indicated would be needed, and the per acre cost of making snow would drop to $2,830 from $4,400. This indicates the importance of accurate test data for each snowgun.

There are many different snowguns in use throughout the ski industry. Although the basic principal of "internal mix" air/water guns hasn't changed much, refinements have produced some interesting variations of the theme. The original snowgun by Tey Engineering (Fig. 12)

SNOWMAKING DESIGN
AIR-WATER SYSTEM

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I. CRITERIA

A. TRAIL AREA	40 Ac.
B. AVG. TEMP.	20° F
C. HRS. OF OPER.	1000
D. SNOW DEPTH	60"

II. DESIGN

A. TOTAL SNOW REQD: = 2400 Ac. In.

40 Ac. × 60 In.

B. DEPTH FOR OPENING:

12 In. = 480 Ac. In.

C. RATE OF APPLICATION:

$10 \frac{Hrs}{Day} \times 15\ Days = 150\ Hrs.$

Or $\frac{480}{15} = 3.2\ \frac{Ac.\ In.}{Hr.}$

D. WATER REQUIRED:

Say $200\ GPM = 1\ \frac{Ac.\ In.}{Hr.}$

Or 200 × 3.2 = 640 GPM

E. GUNS REQUIRED:

From Test Data: 50 GPM @ 20°F

Or $\frac{640}{50} \simeq 13$ Guns

F. AIR REQUIRED:

From Test Data @ 15-20° F

20 to 1 Air-Water Ratio

Or 20 × 640 = 12,800 CFM @ 100 P.S.I.G.

PLATE II

III. COST ESTIMATE

A. WATER SUPPLY:

On Hand (Lake)

640 GPM @ 1000 Hrs. = 38.4 MG

B. AIR SUPPLY:

1. In-Place Electric Comp.
   @ $25/CF = $320,000

Or 2. Rented Diesel
   @ $1.10/CF/MO $42,240
   Fuel @ $.40/Gal, 210 GPH 84,000

C. DISTRIBUTION

1. Pipe @ 40 Ac. – Air & Water
   Avg. Width 200' = 8,000 Ft.
   $20/Ft. Installed 160,000
2. Hydrants:
   40 @ 200' @ $250/unit 10,000
3. Guns:
   13 @ 300 3,900
4. Hose:
   13 × 200 FT × $1.50/Ft. 3,900
5. Pumps, Valves, Bldgs 15,000

D. LABOR & EQUIPMENT

1. 3 Men @ $3.33/Hr
   1000 Hrs. Operation 10,000
2. Equipment
   2 Snowmobiles 1,500
   1 Used Sno-Cat 5,000

PLATE III

IV. SUMMARY OF COSTS

A. OPERATIONAL	$136,240
B. CAPITAL EQUIPMENT	
1. 5 Yr. Depreciation Guns, Hose, Snow Vehicles	2,800
2. Distribution - 10 Yr. Pipes, Pumps, Hydr.	18,500
	$177,500

Or $4400/Ac.

PLATE IV

AIRLESS GUNS

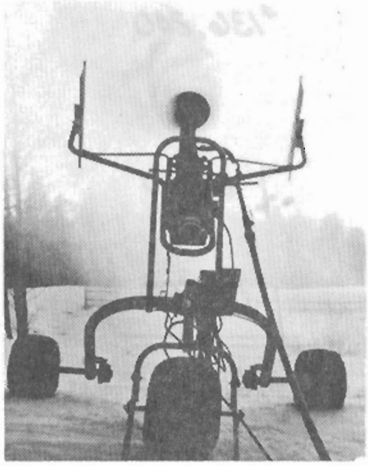


Fig.10 SMI "Snowstream"

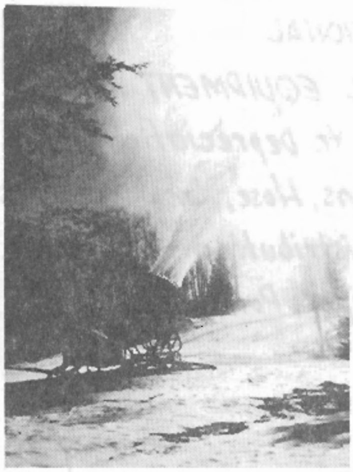


Fig. 11 Hedco "H2d"

Fig.19 Hedco "Mark IV"

AIR/WATER GUNS

Fig. 13 RAB Engr.

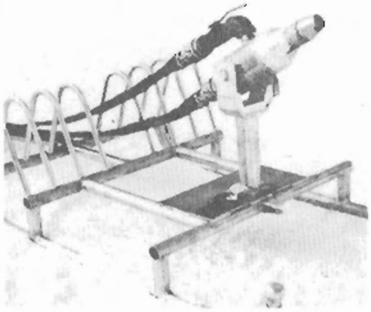


Fig. 14 North American "Snotrol"

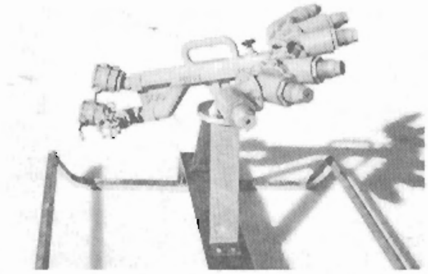


Fig. 15 Larchmont "300"

Fig.12 TEY External Mix

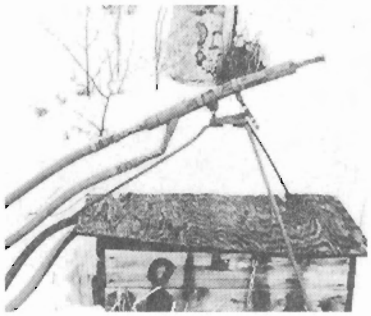


Fig. 16 Killington Homemade

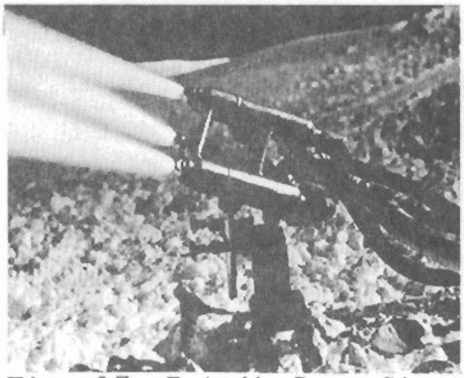
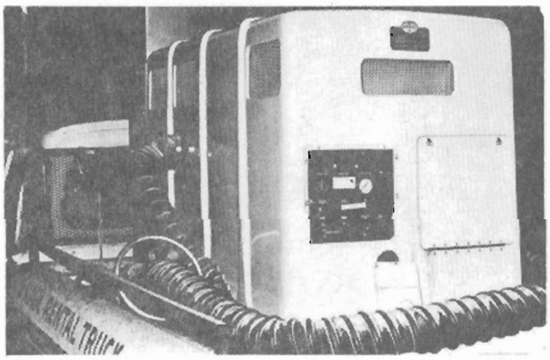


Fig. 17 Ratnik Snow Giant

Fig. 18
2500 CFM Turbine Type
Air Compressor



was an "External Mix" design and was limited to about 10 gpm. Soon, after, compressed air was added to standard irrigation sprinklers which led to the development of the single nozzle snow "gun" @ 25 gpm. From this point on, many varieties evolved from short cannon-type single-nozzle guns (Figs. 13 and 14) to multi-nozzle sled-mounted units (Fig. 15). Obviously, there is always someone who feels he can build a "better mousetrap" as this homemade version shows (Fig. 16).

Until now, you haven't really benefited from this story on snow-making due to lack of sound. Let's add about 95 decibels while the remaining slides are shown (Fig. 17).

What does the future hold for the snow-making industry? As mentioned before, "airless" snowmakers are relatively new and being improved all the time. There is a serious need for developing methods of sewage effluent disposal during low winter temperatures. Some work has been done in this field already. It is quite conceivable that people will soon be skiing on snow made with sewage effluent.

New methods of testing need to be developed for more accurate forecasting of snow production and associated costs. Cheaper, more efficient compressed air (Fig. 18) would be a great asset in these times of energy shortages and escalating costs. One of the most recent innovations in the industry is shown in Fig. 19. Obviously, snowmaking is here to stay, and imagination is not lacking. However, there is always room for new ideas.

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