The Tequila Industry in Jalisco, Mexico

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Abstract

In Jalisco, several liquors are extracted from plants of the genus *Agave* L. Tequila is the most important of these, because of its large national and international market. It is a major Mexican export product. In order to produce the various tequilas, the juices of *Agave tequilana* Weber are fermented, distilled, and prepared in various forms. The principal plantations are located between 20°30′ and 21° north latitude and 102°30′ and 104° west longitude and cover 16,000 hectares of dry-farmed lands with a warm temperate, semi-arid climatic regime. Over 50% of the factories are located in the Tequila region of Jalisco; these account for 80% of the world production.

Introduction

The use of *Agave tequilana* for the production of fermented beverages dates from pre-colonial times. The fermented juices were consumed by priests and nobles as part of religious ceremonies. The beverage was highly nutritious, being rich in proteins, but it was only mildly alcoholic (6%). The production of the distilled liquor itself has a history of over three centuries.

It appears that the first tequila factory was established in 1621. It was a clandestine operation. The manufacture of tequila was illegal, because it was economically threatening to the importers of Spanish distilled liquors. A century later, its production was regularized and placed under government protection. It became a factor of prime importance in the economy of Nueva Galicia, as the Jalisco region was then called (Unidad Editorial del Gobierno de Jalisco, 1980).

Presently in Jalisco, over 16,000 hectares are planted with Maguey Azul, a cultivated variant of *Agave tequilana*. Approximately 50 factories are dedicated to tequila production. In this paper, the process of tequila production is explained step by step, with emphasis on the most essential aspects. The information is based on an extensive literature review, ten visits to plantations for interviews with growers, and visits to eight tequila factories in the Tequila region.

Distribution and Taxonomy

Agave tequilana is cultivated in the states of Nayarit, Michoacan, and southern Tamaulipas, but most of the production is from Jalisco, where there are two producing areas, the eastern highlands and the central area respectively (Figures 1, 3). Within these areas the most important municipios (counties) are: Amatitán, Tepatitlán, Atotonilco el Alto, Tototlán, Arandas, Tequila, Zapotlanejo, El Arenal, Hostotipaquillo, Jesús Maria, Magdalena and Zapopan. Ninety percent of the acreage planted with Maguey Azul in Jalisco is included within these areas. The main area of production is in the highlands of eastern Jalisco, while a smaller area is centered around Tequila, northwest of Guadalajara (Secretaria de Agricultura y Recursos Hidráulicos, 1984). Altitudes vary from 800 m to 2,100 m, while annual precipitation varies from 700 mm to 936 mm, most of which falls in the months of June through October. Annual mean temperatures vary from 16.9°C to 24.8°C. The highlands make up 55.5% of the surface occupied by cultivated agave and are characterized by ferralitic soils. The Tequila area is characterized by well drained soils formed over volcanic pumice.

In general, only one species is utilized in tequila production, although it is possible that different varieties or forms have been selected over time, giving rise to the idea that more than one species is involved. Gentry (1982: p. 582) listed the following binomials as synonyms of *A. tequilana*: *A palmaris* Trel., *A. pedrosana* Trel., *A. pes-mulae* Trel., *A pseudotequilana* Trel., and *A. subtilis* Trel. These names are sometimes used to designate different varieties.

Cultivation

Maguey Azul has been cultivated since pre-Columbian times, and the fund of practical, empirically based know-

Figure 1. *Plantation of Maguey Azul near Amatitan in the center of Jalisco.*

Figure 2. *Young plants of Maguey Azul growing in nursery beds. Notice the side dressing of chemical fertilizer.*

ledge is considerable. In spite of its importance, there has been little scientific research on this aspect of tequila production. There are a few key studies, however.

One pioneer study (Pérez, 1887) states that the plant requires a dry climate and a soil fairly high in clay content. Soils that are too sandy or too calcareous prevent good growth and also reduce the sugar content of the *"piña"*. Another early study (Blanco, 1906) concludes that when conditions are too moist the plant produces less sugar, but that watering young plants hastens sexual maturity. Irrigation should then be suspended some time before harvesting. Modern growers say that the best land has reddish, light-textured soils.

Propagation

Propagation is carried out by vegetative means, using the offsets which are produced by the mother plants every year. These are extracted and planted in nursery beds where they are irrigated, fertilized, and otherwise well cared for (Figure 2). Once the plants are established and reach a fresh weight of at least 750g they can be transplanted to the commercial plantations.

Preparation of the Land

This operation varies according to whether or not other crops are to be interplanted. If interplanting with maize, beans, peanuts, or other annual crops is planned, the land must be prepared by plowing, disking, furrowing, and the excavation of pits, in order to create good conditions for

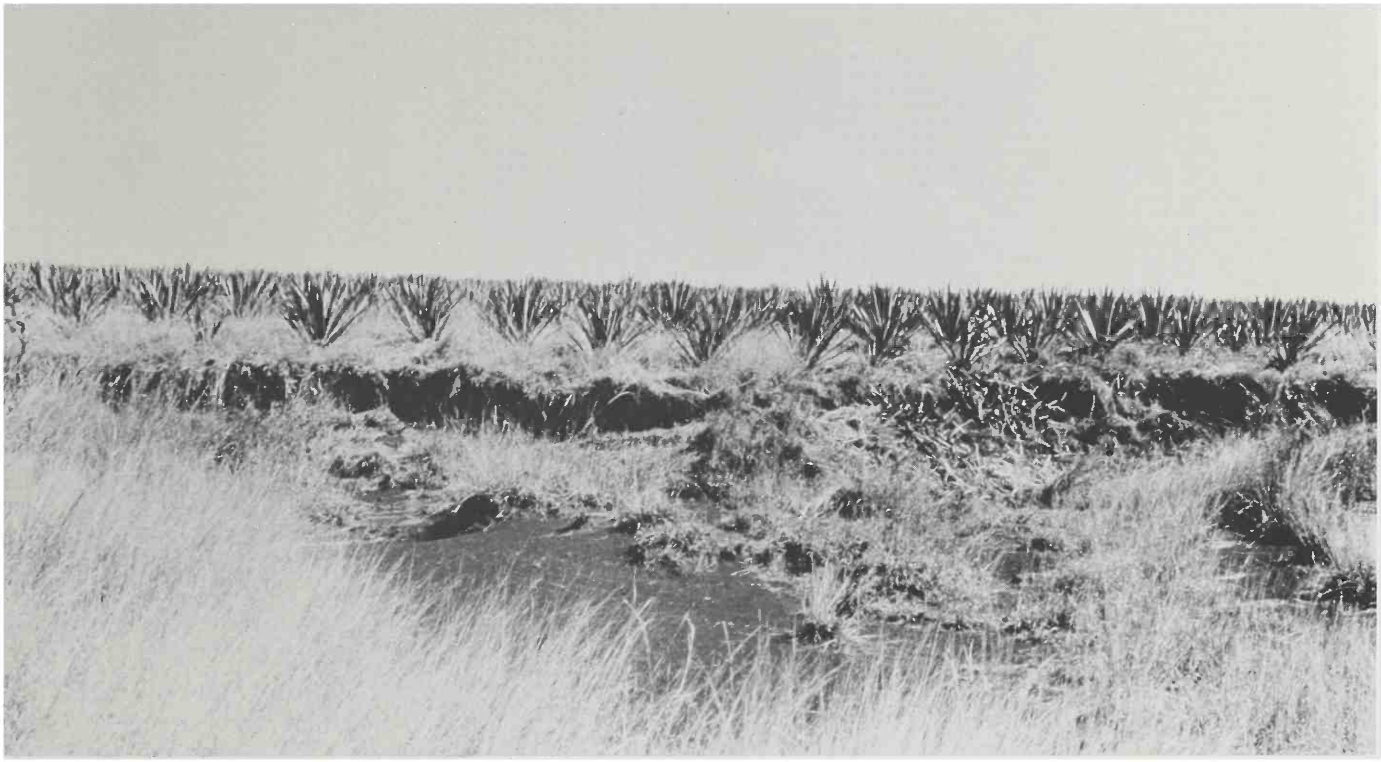


Figure 3. *Plantation of Maguey Azul in the highlands (Los Altos) of Jalisco.*

both the maguey and the annual crop. If the land is sloping, the initial preparation involves only clearing and pit excavation. When this is carried out along contour lines, it favors the formation of terraces where annual crops can later be planted. The topography also influences the sowing density. On steep slopes densities vary from 2500 to 3000 plants/hectare while on flat lands they vary from 3000 to 4500 plants (Sierra; 1973; Gómez, 1984).

Planting

The roots of the offset are almost always treated with a formol-water mixture and left to callus over for a month before planting, in order to prevent rot. Since maguey cultivation is a dry-farming operation (i.e., without artificial irrigation), the planting takes place during the rainy season. The offsets are placed in furrows 30 cm deep. The space between plants in a row is about 1.8 m, while the space between rows depends on the interplanted crop. In agave monoculture this distance is about 3 m.

Practices carried out in commercial plantations include chemical, mechanical, or manual control of weeds (Serrano, 1976) , application of chemical or organic fertilizers and soil conditioners, and disease and pest control.

Inflorescence Removal and Pruning

The age at flowering is variable; the inflorescence bud may appear at any time after the fourth year. In order to prevent flowering, the young inflorescence *(quiote)* is cut off, a process called *"desquiote"*. This forces the plant to store its carbohydrates in the stem, which increases in size and becomes the *"piña"* which is eventually harvested.

Every year during the growth period the older leaves are cut off, and a few months before harvesting the tips of all the leaves are removed. This is said to stimulate the concentration of sugars in the stem (Bustamante, 1984).

Harvesting

Harvesting is carried out when the leaf bases begin to shrink and become chlorotic and when a transverse cut through the inflorescene base reveals dense, close-packed tissue. All the leaves are cut off at the base, leaving behind the almost spherical stem (*"piña"* or *"cabeza"*). This is pried out of the ground and delivered to the processing plant (Figure 4).

Industrial Process

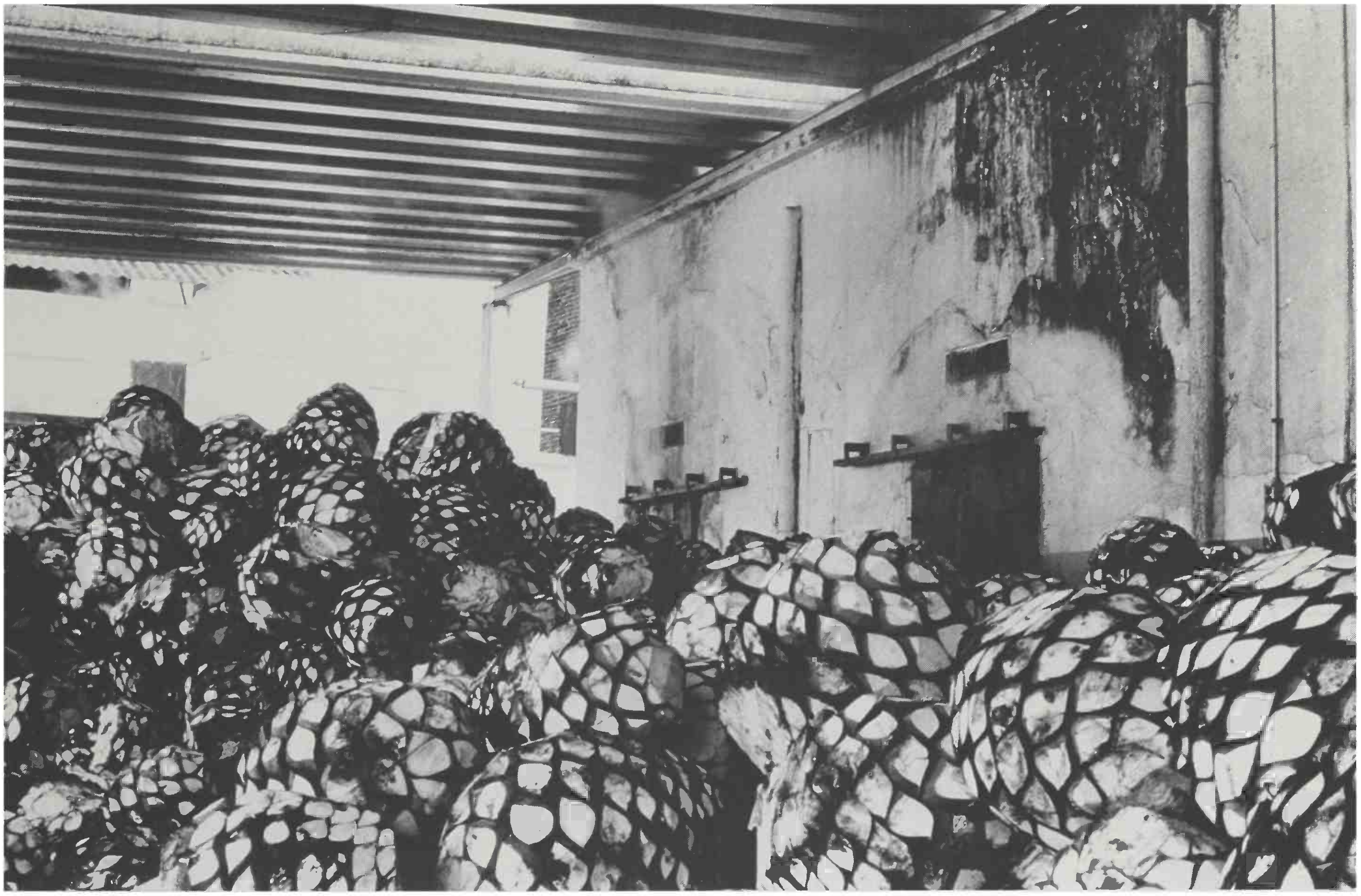
The industrial process for the production of tequila is basically the same in all the factories, but relatively minor differences result in tequilas with slightly different flavors.

The constant aspects begin with the cooking of the *"piña"*, which converts the stored polysaccharides (inulins) to fructose and glucose. These are then extracted by milling and pressing the cooked material.

The sugars are fermented, usually in a mixture with 49% sugar from other sources (cane and sorghum), although tequilas made of 100% maguey sugar do exist. These are the tequilas most prized by connoisseurs. The fermented mash is then doubled-distilled, and the resulting liquor is subject to quality control analysis prior to its sale.

Cooking and Syrup Extraction

Cooking is carried out with steam heat, in traditional ovens or in stainless steel pressure cookers with cooking times of 48 and 12 hours, respectively. The cooked material is transported on conveyer belts to a mill where it is shredded with rotary knives and washed with potable water under



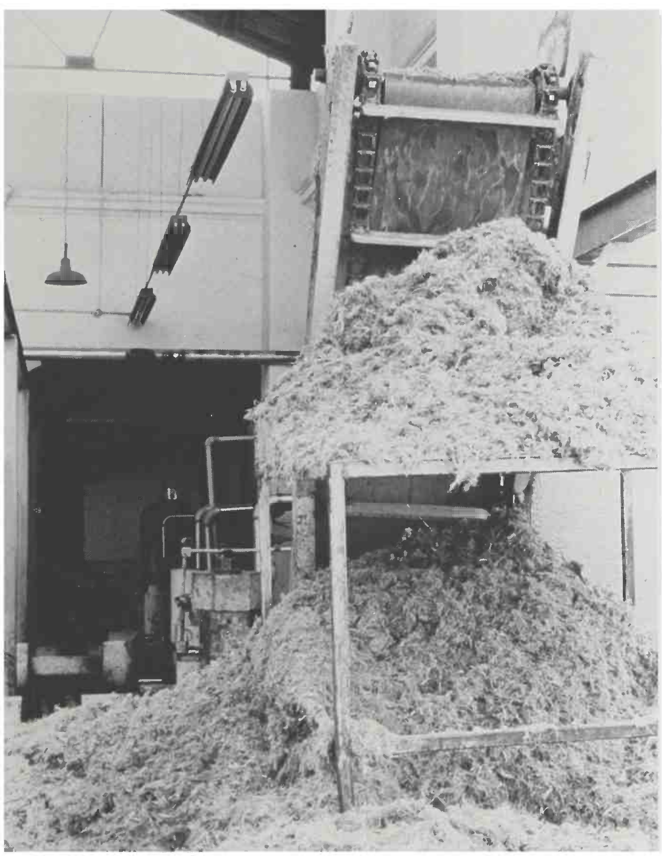


Figure 4. *Agave hearts from which most of the leaf material has been removed are referred to as* cabezas or piñas. *In this photo they are stacked in front of the* hornos *(ovens) just prior to heating. The treatment in the ovens converts complex polysaccharides to simple sugars: fructose and glucose.*

Figure 5. *After milling to mechanically break up the heated* cabezas, *a press separates syrup from waste fiber,* bagazo. *Here a conveyor belt deposits the* bagazo *away from the press.*

pressure to dissolve the sugars. Finally, the material enters a press where the syrup is extracted, leaving behind the fiber.

The fiber, or "*bagazo*", is the first waste product of the industrial process (Figure 5). It is currently used as fuel, furniture stuffing, fodder for livestock, organic fertilizer, and in brick manufacture. The University of Guadalajara has experimented with other uses for this waste fiber, including silage, fiberboard (Nava, 1978), paper (Salcedo, 1961), livestock nutrient supplements (Guzmán, 1977), and cellulose (Daza, 1974). The results indicate that it has many potentially profitable uses.

Fermentation

This is the most important phase in the production of tequila (Correa, 1978; Avalos, 1982; Mendoza, 1977; Terrazas, 1976). The sugars are converted to alcohols, and other compounds, such as esters and aldehydes are formed. The yeast strains belong to the genus *Saccharomyces; S. cerevesiae* is the most commonly used species. The fermentation is carried out in vats, generally of stainless steel (Figure 6). The adjusted yeast culture and nitrogen and phosphorus nutrient salts are added to the sugary juices which have come from the press. In order to insure that fermentation is effective, factors such as temperature, pH, yeast strain and adjustment, type and concentration of nutrient salts and enzymes, and

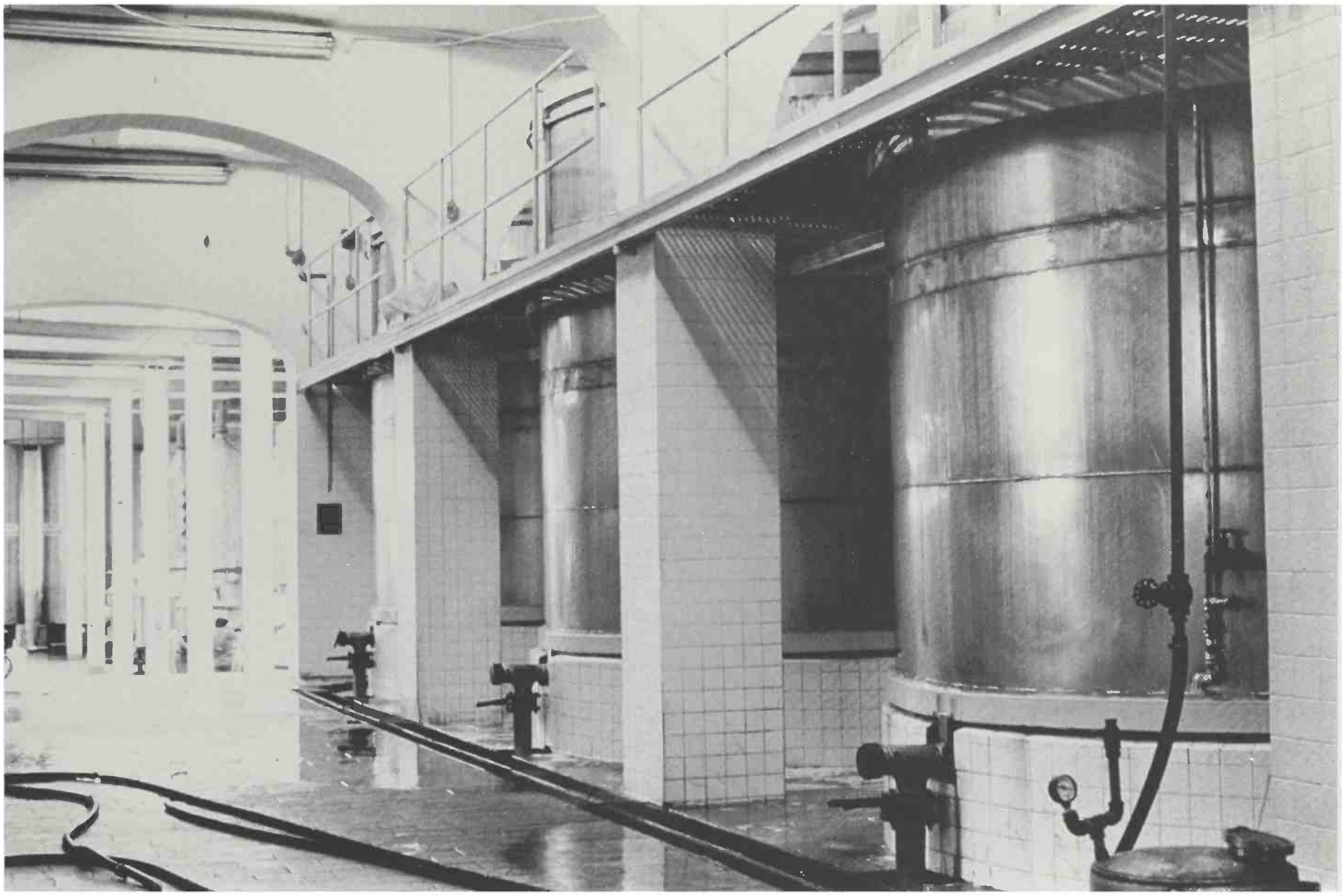


Figure 6. *In the fermentation tanks yeasts of the species* Saccharomyces cerevesiae *feed on the sugary juices from the press. Chemical fertilizers are added to the liquid to provide nitrogen and phosphorus to improve yeast action. The stainless steel vats pictured here are in the Cuervo distillery.*

fermentation time are controlled. Each factory has developed a slightly different version of the process. The alcohol content at the end of this stage is 4-6%.

Distillation

As was mentioned earlier, two distillations are performed in the production of tequila. The first is called "breaking" and it consists of distilling the fermented mash (Figure 7). *"Tequila ordinario"* and *"vinaza"* are the products. The latter is considered a waste product, but has potential uses in human and animal nutrition and as fertilizer (J. Reza, personal communication).

The second distillation is called "rectification" and it consists of distilling the *"tequila ordinario"* to obtain *"tequila rectificado"*, which has a higher alcohol content. The first and last volumes of this process, called "heads" and "tails", constitute another waste product, which is currently used as a solvent for paints. The primary product of the second distillation is sold as *"tequila blanco"*. It may be exported in bulk or diluted to 90 proof and sold in the national market. It may also be subjected to additional treatments such as resting in oak casks (which yields golden tequila) or in containers which do not substantially change the flavor.

Before the tequila is sold it is subjected to quality control analysis to determine its proof and its content of methanol, higher alcolols, and other impurities (Sánchez, 1980).

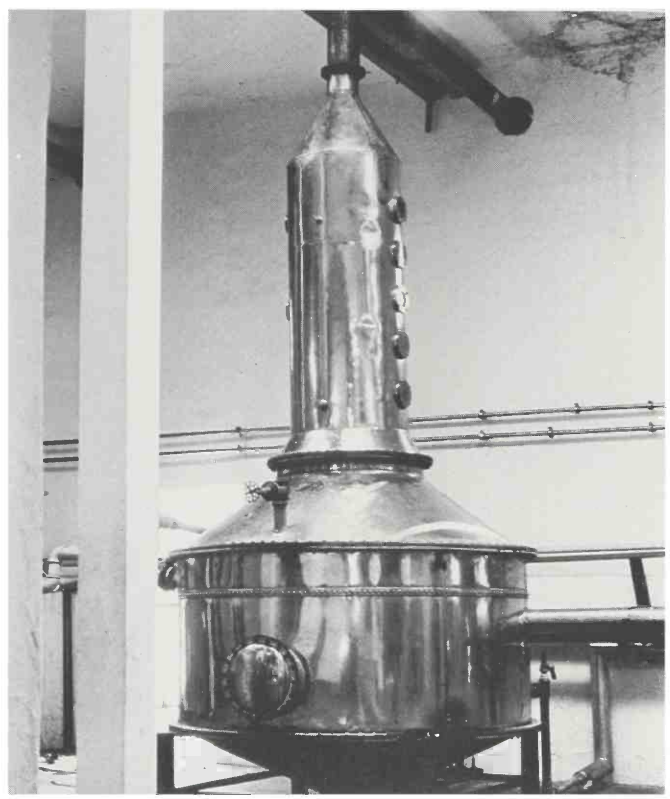


Figure 7. *In this copper "breaking" still,* tequila ordinario *is separated from* vinaza, *the waste. A second distillation (termed "rectification") yields* tequila rectificado *of higher alcohol content and with fewer impurities. The beginning and ending fractions of the retification process, called "heads" and "tails" are used as a solvent for paints.*

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