Ref. 326

SECTION VI — CONTROL TECHNOLOGY

GLASS FIBER MANUFACTURING PROCESSES

Two glass fiber manufacturing operations are presently located in the study area; Owens-Corning Fiberglas Corp. and Gustin-Bacon Manufacturing Co., both in Kansas City, Kans.

Atmospheric emissions from these operations are a problem because of the amount and small particle size of the particulate matter evolved. There are three principal sources of particulate within each plant: (1) glass furnaces, (2) glass fiber forming lines, and (3) curing ovens. Of the emissions, those from the forming line appear to be the most voluminous and most difficult to control.

The manufacture of glass fibers consists of melting a feed mixture composed largely of silicon, calcium, and aluminum oxides at about 2800°F in a large furnace to form glass. The molten glass is drawn through small nozzles to form glass fibers. These fibers are sprayed with a phenolic resin binder while still very hot and then air dried and cooled on the forming line. The resin-bonded fiber mats are passed through a curing oven for final heat treating and drying.

Particulate emissions from glass-making furnaces average 2 to 4 pounds per ton of finished glass and vary with the feed composition and furnace temperature and design. The emissions are largely in the form of condensed metal oxides and raw material particulate carry-over.

Based on data obtained at glass container plants, about 30 to 40 weight-percent of this particulate matter is less than 5 microns in diameter.

Emissions from the forming line are caused by evaporation and subsequent condensation of the resin binder that is sprayed on the hot glass fibers as they emerge from the forming nozzles. This fine condensed particulate material, which escapes from the building, is largely sub-micron in size as measured by samples taken in the plume near the plant. Since no atmospheric emission data are available on glass fiber forming lines, these emissions were estimated to approximate emissions from rock wool forming lines.

The curing ovens vaporize additional amounts of resin binder; this resin condenses upon cooling and causes a visible emission. The amount of such emissions depends largely on oven temperatures.

No glass fiber production data were supplied by either manufacturer, and atmospheric emissions were therefore difficult to estimate accurately. However, based on emission data gathered at other

3

Ref. 325 see Dick Gentley, RRI

Reference 327 1-175-1
10-26-69

N.J.- data on fiber glass - summary

forming line
avg 117.5#/day ÷ 5 ton/day = 23.5 #/ton

curing oven
#1 70 #/day ÷ 5 ton/day - 3.4-14 #/ton 3.4
17 14.0

#2 32 ÷ 5 ton/day -
18 3.6 - 6.4 #/ton 3.6
6.4

#3 25 ÷ 2 1/2 ton/day = 10 #/ton 10.0

5 / 37.4

avg = 7.5#/ton
from curing oven

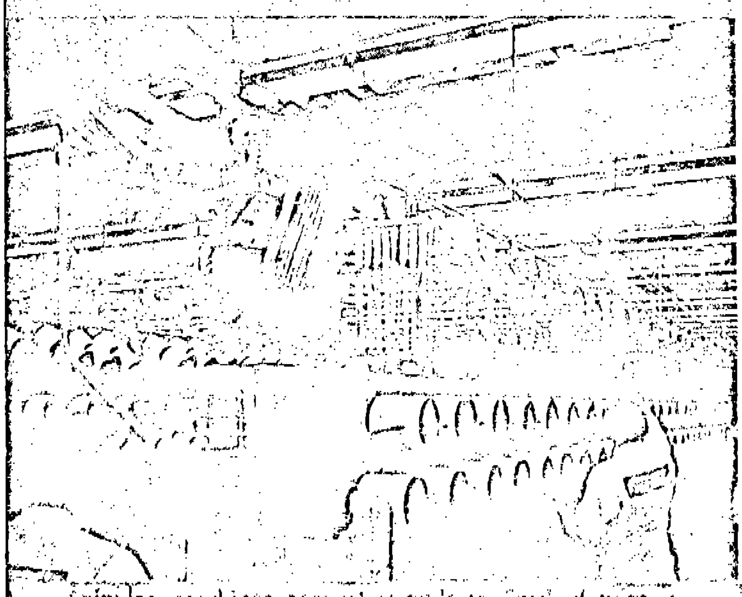
glass furnace 2-4#/ton [illegible]
[illegible]
K.C. [illegible]

mineral wool curing oven = 4#/ton - Eng manual
pg 344

E.F Chap 7.9 75 General

Building wings each contain five glass furnaces.

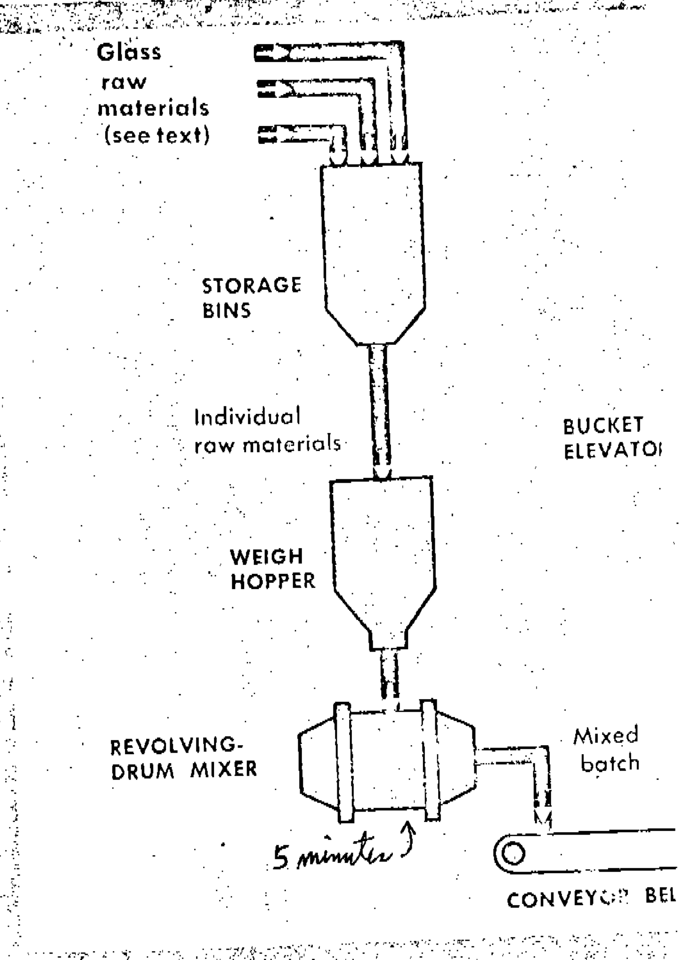
Recuperative furnaces house basic glassmaking step.



Spinning machines convert strands to finished yarn.

New Plant Features Latest Look In Making Glass Fibers

N. P. CHOPEY, *Assistant Editor*



Two facts, not unusual in themselves but rarely found in combination, characterize the glass fibers business. It has grown breathtakingly since its infancy in the 1930's; its history has coincided with the life of one principal producer.

The producer, of course, is Owens-Corning Fiberglas Corp., which made glass fibers a commercial reality some 25 yr. ago. Indeed, company is so closely identified with the field that its Fiberglas trade name is often mistaken for the generic term when discussing these versatile fiber materials.

With six producers in the field, Owens-Corning's 1959 sales—$211 million—represented a healthy 72.9% of total. Although 1960's $218-million sales figure didn't meet company expectations, industry experts have it that the glass fibers field will continue to be a prolific one (*Chem. Eng.*, Aug. 8, 1960, p. 72).

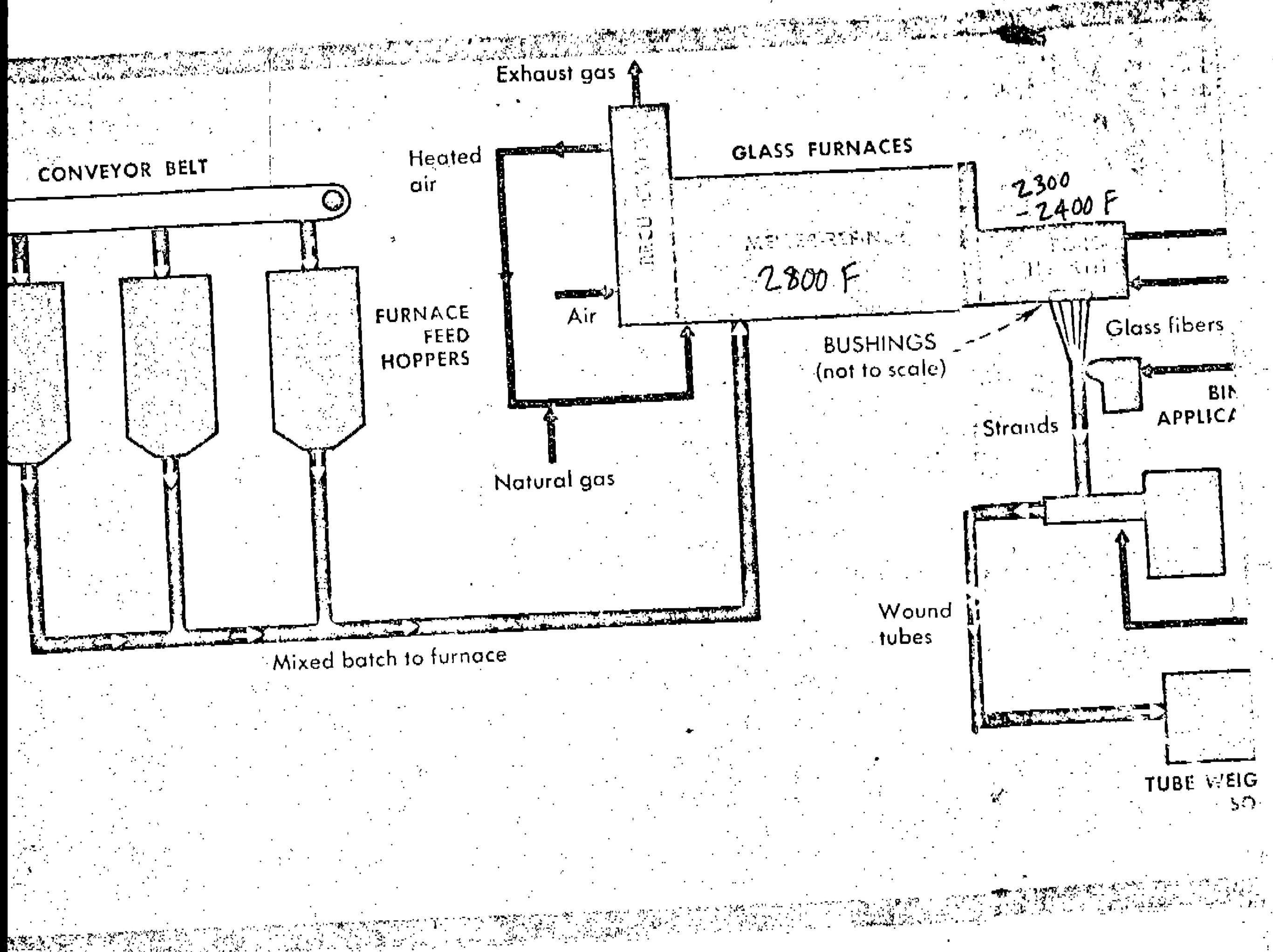
Evidence that the company intends to grow with the market is provided by a huge, highly modern plant that was started up last year to make continuous-filament yarn at Aiken, S. C. Capacity depends on the slate of product grades made—heavy fibers are easier to produce than light ones—but a representative figure is over 50 million lb./yr. (1960 - 61)

The facility produces fibers in about eight basic diameters, which in turn are combined to yield yarns of various plies. Currently, the big market for continuous-filament yarn is for textiles. Principal textile uses are in drapery and decorative fabrics; others include reinforced plastics and electrical insulation.

▶ **Last Word in Processing**—Process modernity of the Aiken plant can be seen by comparing its flowsheet with Owens-Corning technology as described in June 1947 by *Chemical Engineering*.

General sequence for making continuous-filament yarn is easily summarized. Glass raw materials are proportioned and combined, then charged to a furnace. Molten glass passes through orifices and the filaments thus produced combine into strands, which in turn are spun to form product yarn. The specific modernizations that Owens-Corning engineers have woven into this procedure at Aiken show up clearly when process flow through the plant is followed.

PROCESS DESCRIPTION



Batching—Company's basic ingredi-
r continuous-filament fiber is as fol-

ide	52-56%
de	16-25%
oxide	12-16%
e	8-13%
potassium oxides	0- 1%
oxide	0- 6%

ong-alkali level is typical for glass-fiber
ns, to reduce susceptibility to corrosion.
this low content, the glass-forming re-
s place at a higher temperature than
ng, for instance, plate glass.
r cars convey the raw materials from
ing to batching facilities. Aiken's batch-
rnishes the first evidence of the plant's
—it operates fully automatically, con-
m a central programming board.
igh hopper proportions the individual
s, discharges them into a revolving-
er. Mixing time is about five minutes.
ined batch is then conveyed to feed
n the furnace area.

▶ **Modern Furnace Design**—Aiken's glass furnaces are also worthy of notice. For one thing, they feature a recuperative rather than regenerative system for heat recovery from spent fuel gases.

Regenerative furnaces recover heat by alternately passing exiting hot gas and incoming air across brick checkerwork. In the recuperative system, heat transfer takes place continuously between gas and air in adjacent passages.

Designers of large glass furnaces have generally avoided the latter system in the past, because it can lead to leaking or clogging problems. Owens-Corning, however, likes the more-accurate temperature control inherent in recuperative operation and is using carefully designed recuperative furnaces at Aiken. (Company is phasing into this type of operation at its other plants as well.)

Without disclosing details, firm's engineers also state that the furnaces incorporate what is believed to be the optimum ratio between hearth length and width.

Melting temperature is around 2,800 F. The molten glass produced passes through the refining portions of the furnaces, then on to forehearth

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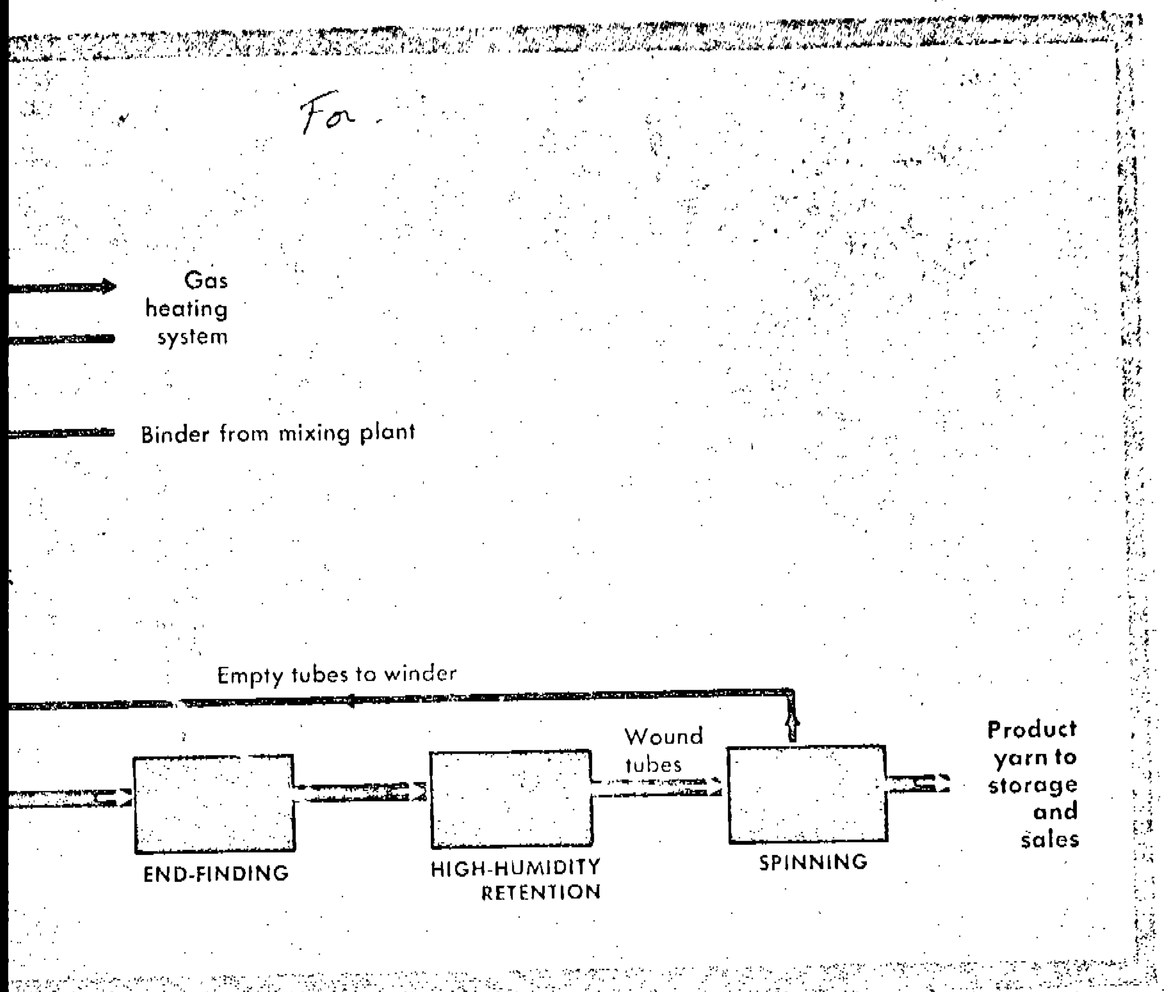


e temperature is kept in the 2,300-
e. Temperature control is especially
re, so the forehearths are heated by
nt gas system.
aments are drawn directly from the
and this procedure constitutes the
of the new plant.
Marbles—In earlier continuous-fila-
on, glassmakers formed the melter-
ct into marbles. These were inspected
then remelted in an electric furnace
drawing. Owens-Corning feels that
now-how in glass technology, as built
nt batching and furnace design, per-
ng the marbles step—except in the
fine fibers, not produced at Aiken.
glass emerges from the forehearths
fices in platinum-rhodium bushings.
ment diameter is about 0.00025 in.;
ies this by changing the bushings.
d Winding—The filaments are gath-
r and treated with a binder material,
ng machine then collects the resulting
spindle.

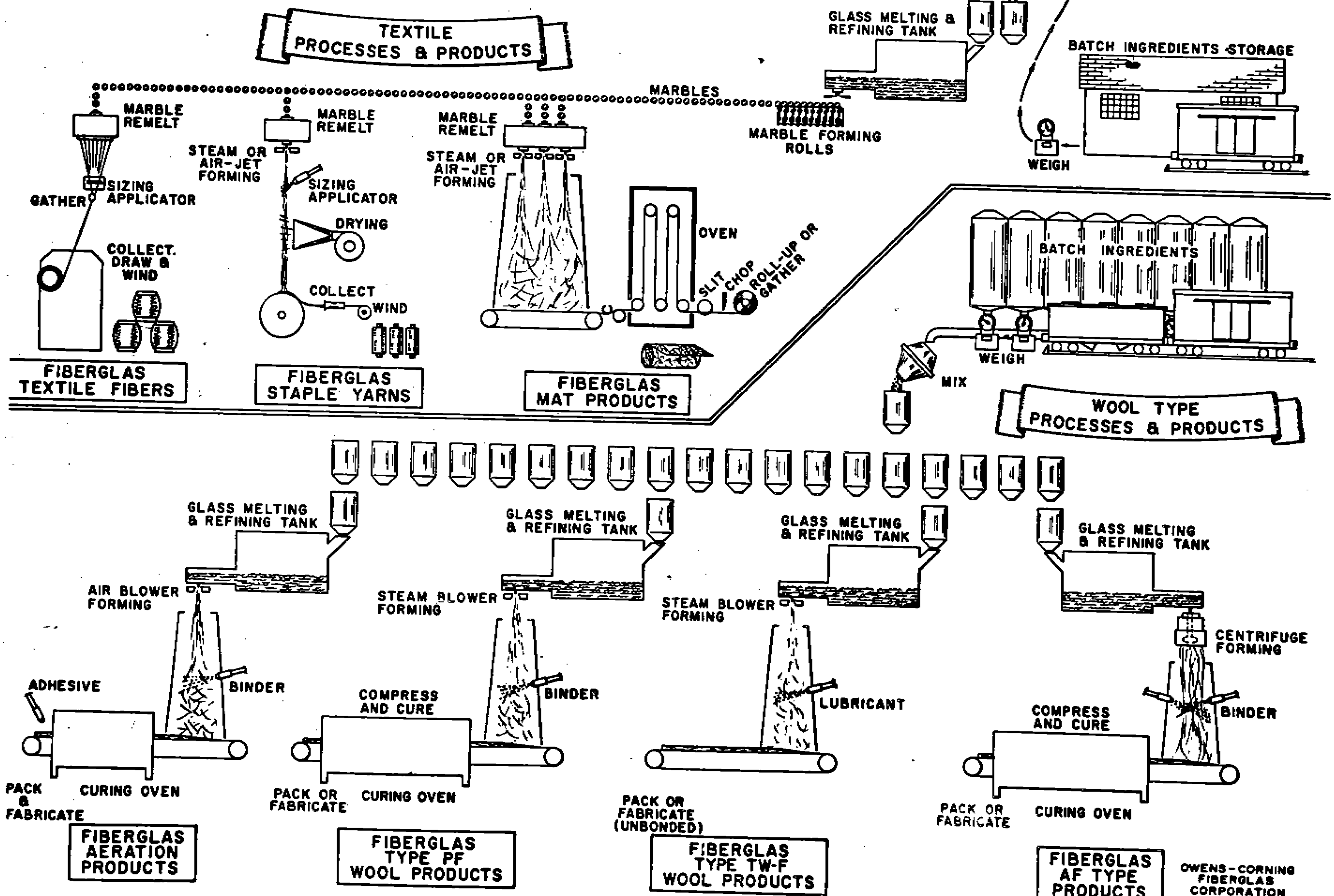
Processing the binder materials is also a modern operation at Aiken, but one that Owens-Corning will not elaborate upon. Company uses various formulations of starch-based substances, produces them in a complex, automated unit.

The winding step has three features that distinguish it from older practice. To achieve precise control of speed (there is an optimum winding speed for each filament diameter), a d.c. drive system that incorporates a motor-frequency generator is used, rather than a conventional a.c. motor. The packages of wound strand are bigger than in the past, and when finished they are automatically taken away from the winder.

▶ **Finishing**—Tubes go to a weighing station for inspection, then to a manual operation for finding the ends of the strands. Next, the tubes are stored under conditions of high humidity, to allow the binder to set. Minimum retention time varies with the binder used, can be 1-16 hr.

An efficient monorail system routes the tubes from the storage area to spinning machines, which twist and ply the strands into finished product fiber.

HOW OWENS-CORNING FIBERGLAS IS MADE



OWENS-CORNING FIBERGLAS CORPORATION
TOLEDO, OHIO

PUB. NO. 5-GL-1810

LITHO IN U.S.A., MARCH 1960

times in conjunction with other fibers, such as Orlon, Dacron, acetate, rayon, or natural fibers, which are wrapped around a core of the elastic spandex fiber.

POLYOLEFINS

Polyolefin fibers and films are represented by polyethylene film, widely used as a wrap, and the polypropylene fibers.[1] The latter have excelled in special cases, such as ropes, laundry nets, carpets, blankets, and sweaters. The fiber is moth-resistant and low-priced since it is made from 4 to 5 cents per pound propylene. As its dyeing is satisfactory, its market will expand rapidly above its present (1965) annual consumption of about 50 million lb. Polyethylene film is being extensively exploited as a heat and water saving mulch for cotton, strawberries, melons, and vegetables. Weed control is also claimed. The future growth appears promising.

FLUOROCARBONS

Teflon is polytetrafluoroethylene ($(C_2F_4)_n$) (Chap. 20) and as fiber or film is nonflammable and highly resistant to oxidation and action of chemicals, including strong acids, alkalies, and oxidation agents. It retains these useful properties from >450 to 550 F and is strong and tough. A very important property is its low friction, leading, with its chemical inertness, to wide use in pump packings and shaft bearings.

GLASS FIBERS

Fiber-glass wearing materials were prepared as early as 1893, when a dress of fibers about five times the diameter of the present-day product was made by Michael J. Owens. Since that time, however, numerous improvements have been discovered, until at present fibers as small as 0.00002 in. in diameter and of indefinite length are possible. The largest and original (1938) producer of glass fibers is the Owens-Corning Fiberglas Corporation, which markets under the trade name of *Fiberglas*.[2] Sales in 1964 were over $400 million, with thermal and acoustical insulation accounting for about 56%, textiles for 35%, and 9% for many miscellaneous uses.

Glass fibers are derived by two fundamental spinning processes: blowing (glass wool) and drawing (glass textiles), as outlined in Fig. 35.8. The textile fibers[3] can be made as continuous filaments or staple fibers, and are manufactured from borosilicate glasses composed of 55% silica and substantial amounts of alumina, alkaline earths for fluxing, and borates. The low strong-alkali level is to reduce susceptibility to corrosion. This glass for textiles must be equal in purity to the better grades of optical glass and, when molten, must be free of any seeds or bubbles that would tend to break the continuity of the fiber. In the continuous-filament process, specially prepared and inspected glass marbles are melted or a batch of molten glass is particularly purified. Either is allowed to flow through

[1] *CW*, Oct. 6, 1962, p. 89; AATCC 1964 technical paper, Dyeing of Polypropylene for Textiles, *Am. Dyestuff Reptr.*, 54 (4), 34 (1965) (10 pp., many references). See Chap. 34.

[2] Games Slayter, inventor; Kozlowski, Fiber Glass Industry, *Glass Ind.*, vol. 41, no. 6, 1960 (products, applications, companies, techniques, and properties); Koch and d'Hauteville, Glass Fibres, *Ciba Rev.*, 1963-1965

[3] Cf. Chopey, Glass Fibers, *CE*, 68 (10), 136 (1961) (outline flowchart); Haveg, Steps Up Silica Fiber Activ..., *C&EN*, Mar. 13, 1961, p. 30.

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and low-priced
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also claimed.

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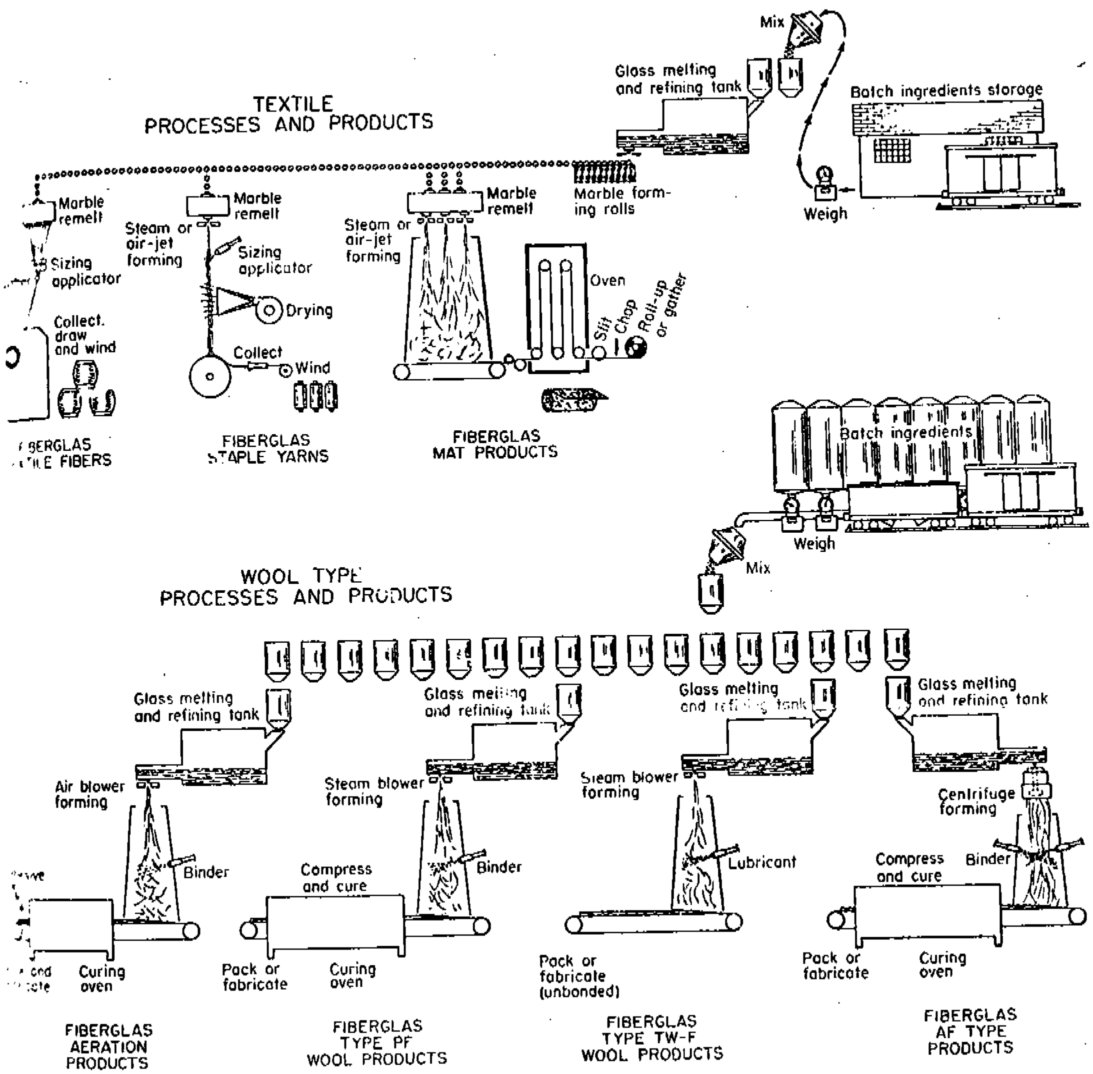

Fig. 35.8 Flowchart for Fiberglas. (*Owens-Corning Fiberglas Corp.*)

Basic Ingredients for Continuous-filament Fiber, %

Silicon dioxide	52–56	Boron oxide	8–13
Calcium oxide	16–25	Sodium and potassium oxides	0–1
Aluminum oxide	12–16	Magnesium oxide	0–6

a set of small holes (usually 102 or 204 in number) in a heated platinum bushing at the bottom of the furnace. The fibers are led through an "eye" and then gathered, lubricated, and put on high-speed winders, which rotate so much faster than the flow from the bushing that the filaments are drawn down to controlled diameters. It is used for electrical insulation in electric motors and generators, structural reinforcement for plastics, and fireproof wall coverings.