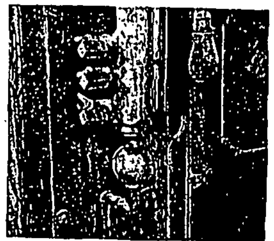
OPERATORS' NOTEBOOK 66

Install Gage Glasses Right for Long Service

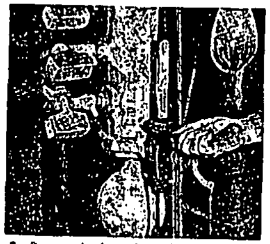
By STEVE ELONKA
Associate Editor



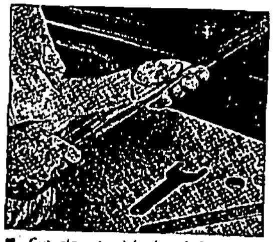
1 Glass thins mostly above water line; also breaks with fittings out of line

2 First shut off top and bottom cocks with chains when the glass breaks

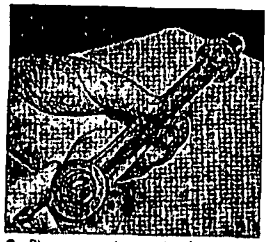
3 Then open drain valve on column that is used for blowing down the glass



4 Remove broken glass, then open cocks from floor to blow out broken pieces



5 Cut glass to right length by revolving between cutters until it breaks



6 Place top washer, and then nuts (not shown); bottom washer; then install

7 Add graphite to washer so nut does not twist glass; hand tighten only

8 Heat slowly by blowing steam at top. Open cocks from floor; close drain

Round Glass

LIKE OTHER CERAMICS, glass is b[illegible] does not deform before failure. It [illegible] tures only from tensile stresses, [illegible] from shear or compression. Stress-[illegible] curve is straight line to the break[illegible] point.

Glass has high degree of "notch-[illegible] sitivity." Tiny surface scratches, bruis[illegible] or imperfections cause failure. S[illegible] careful when handling gage glass[illegible] Keep them in wrapper until ready [illegible] install. If you must put them do[illegible] place on soft, clean surfaces.

Glass can be heat-treated to raise [illegible] *endurance limit. This is know*[illegible] "tempering." First, glass temperat[illegible] is raised high, then it's chilled. Th[illegible] sets up residual stresses that are ten[illegible] in interior and compressive at surfa[illegible] And it's at surface where tension u[illegible] *starts. Tempering* also tends to red[illegible] harmful effects of surface bruises [illegible] scratches. But tubular gage glasses [illegible] not as "adaptable" to tempering as [illegible] glasses.

Corrosion is tough on gage glasses [illegible] caused by alkalinity and temperatur[illegible] Most corrosion (thinning) on tubul[illegible] glasses is above water line at upper h[illegible] Here steam condenses and continu[illegible] flows down glass, eroding it. Boil[illegible] water with pH *of* 11.5, *for* examp[illegible] attacks glass 30 times faster than wa[illegible] with pH of 8.5. That shows importan[illegible] of low pH *if* you *have* glass-thinni[illegible] problem. Rate of attack from tempe[illegible] ture increases 100 times from 265 [illegible] 500 F. Solution then is to use flat gl[illegible] protected by mica so water does [illegible] contact glass.

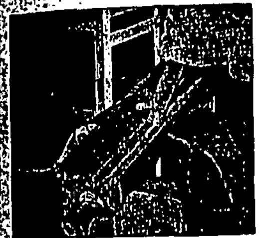
Of course, water in gage is coo[illegible] than water in boiler. Some condensate [illegible] formed in boiler connection above ga[illegible] flows into gage and lowers alkalinity. This condensate dissolves some silica [illegible] glass because of decomposition.

Silica content increases as conde[illegible] sate flows down over glass. Rate of co[illegible] rosion below water level depends [illegible] silica *remaining in* gage water. Rate [illegible] water attack above water level is less [illegible] distance increases from top end of gla[illegible] to bottom. Boiler water, not treated [illegible] silica removal, corrodes glass.

For over 300 psi, it's best to use fla[illegible] glass, protected with mica. Pressure [illegible] limits for tubular glass decrease wi[illegible] glass length. Buckling stress is the [illegible] sult of eccentric column loading.

1 Mica, protecting glass from steam and water, turns opaque before failure

2 Remove clamps, glass gaskets, mica. *Graphite the threads, run them down*

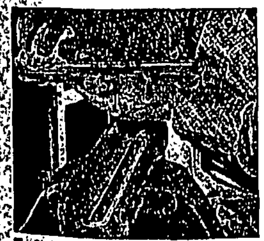


3 Remove old gasket but don't scrape low spots in joint surface of gage

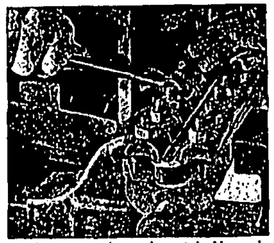
4 Polish surface perfectly smooth or the tiny high spots will cause failure

5 Clean both ends of gage so scrapings won't plug cocks when back on drum

6 Clean surface thoroughly, oil with molybdenum disulfide so glass slips



7 Place new gasket, mica, new clean glass, another gasket; place clamps



8 Glass mustn't touch metal. Use only molybdenum disulfide on high temp

Flat Glass

ON HIGH-PRESSURE boilers above 1000 psi, there have been many costly gage-glass failures running into thousands of dollars. But fault has been from gage design, as well as from method of installing glass, rough handling and glass imperfections.

At Corning Glass Works, I saw a nail driven into wood with a flat glass. This is possible because high residual stresses push out against the outside high compressive-stress, which was set by tempering. Here are failure causes, ways to prevent:

(1) Never reuse gage glasses. (2) Use special glasses only for high-temperature service. (3) Under extreme pressure, gage metal tends to bulge out, so gage bends if designed poorly—starts a crack because glass won't bend. (4) Scraping gasket off metal raises burr—causing high unit loading. Always polish gage surfaces perfectly smooth. (5) Numerous scrapings to remove gaskets create high and low spots. Level old surfaces. (6) Pulling up unevenly on *bolts loads* glass unevenly. (7) Asbestos is "lumpy" in gasket, causing high spots. Use only best gasket material.

(8) Many failures occur on high pressures when starting up because glass was not heated gradually. Don't open gage cocks until new glass has chance to heat by conduction. Then crack top-cock only. Also, cool down slowly. (9) Don't blow down oftener than needed. (10) Use two valves for blowing down. Keep one throttled for slow flow through glass, blow with other valve only.

(11) Lubricate contact surfaces of glass with molybdenum disulfide only. This does not crystallize, allows travel between glass and fitting. (12) Don't use cover plate if it has permanent deflection, if it's of poor design, or if clamping-device design is poor. (13) Mica discoloration means that mica has failed and water contacts glass. Don't wait for glass to fail—change it.

High pressures and temperatures in newer boilers (around 2000 psi) bring new problems. Flat glasses are strengthened by tempering, but residual stresses or strain set up may release at high *temperatures*. Over long periods, glass loses much strength that was added by tempering. So when ordering glass, consider pressure and temperature.