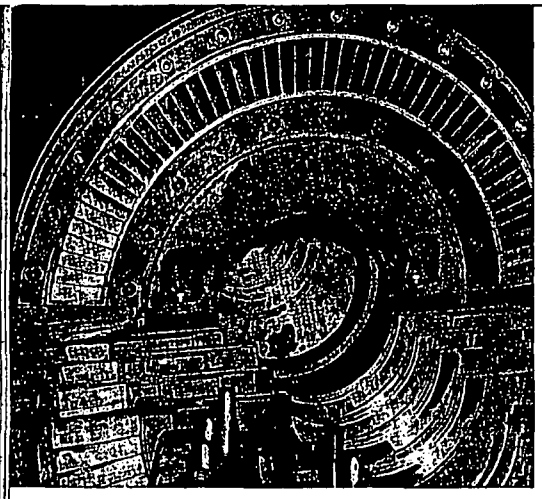

EXTRACTION nozzle plate for automatic extraction at 5-20 psig from fifth stage. Labyrinths are springloaded, held in diaphragm shoulders



NOZZLE-RING and reversing-bucket assembly Allen-screwed into top half of the turbine casing



REMOVING SCALE from low-pressure diaphragm takes time—lots of patience



FIRST-STAGE nozzle ring is made up of series of accurately milled units shown



MEASURING SLOT for straddle T-fastening in turbine-wheel forging, with vernier

Periodic Checks Will Save You Costly Maintenance

pair leak, fill system with clean oil before starting turbine.

Dirt and grit in oil abrades bearings and wears all other working parts oil services. To prevent dirt entering, keep bearings and all openings covered except when you can't avoid it during repair. Keep oil tanks closed with covers *bolted down. At best, some dirt and* dust will get in. There are also bits of rust, scale, and results of oil decomposition. Remove often by purifying oil.

Inspect and clean oil strainers at regular intervals. Letting cleaning go may clog strainers and increase pressure drop across screen. Then screen may burst, spilling all collected dirt into bearings and governor hydraulic system.

Acid-free lube oil may become slightly acid through use. Check corrosive action once a quarter by sending oil sample (drawn from system) to lube-oil firm for analysis. If oil is acid enough to cause corrosion, replace with new oil.

Bucket Inspection. Inspect rotating and stationary buckets *at each inspection* period for signs of rubbing, loose buckets in fastening, broken shrouds, chipped buckets, deposits and erosion. Wear on inlet and outlet edges of rotating and stationary buckets is from wet steam or solids in steam.

Most bucket wear is often from saturation through last row because of steam's higher moisture content there. *Moisture tears at bucket tips, gradually* wearing them away. In time, ragged saw-tooth edges develop. File smooth at inspection time, and replace these buckets when they wear about ¼ original width.

Rotor and Stationary Element. When inspecting, get total end play of turbine rotor between striking points. Compare with original condition to see there's no obstruction causing reduction in running clearances. Set rotor for high-pressure nozzle with manufacturer's data.

Clearance gage for rotor's running position usually comes with turbine. Check rotor position once a day when turbine is running. Recalibrate clearance gage carefully after every rotor *overhaul.*

Years of operation, also temperature changes from starting-stopping, and load changes cause growth and distortion of turbine casing, rotor and stationary elements. If there are changes between inspections, correct by lining up rotor with stationary elements.

When first installing, and at each inspection, turn rotor slowly while indicating rims of turbine wheels. Take clearances between each wheel and diaphragms on both sides of wheel rim.

If comparing records shows that total end play is reduced to danger point, remachine locating-tongues of diaphragms. Clearance between hub at inlet and outlet side of each turbine wheel and its diaphragms will show if diaphragm has distorted. If distorted *enough to reduce total end play* in rotor, you may have to rework diaphragms. Get end limits on distortion from turbine maker.

Shaft Seals. When opening turbine, inspect high-pressure and intermediate labyrinths for clearance between rotating and stationary elements. Renew labyrinth if worn clearances have doubled. Straighten and scrape smooth rolled fin-edges, to prevent cutting down rotor end play.

Recondition shaft surfaces under carbon packings if necessary. If there are shaft-protecting sleeves at these points, renew them. Otherwise, metal-spray worn surfaces and regrind shaft to original diameters.

Refit carbon rings' clearance between rings and *journals to maker's recommendation.* But make sure butt ends are square, to avoid excessive leakage when running turbine.

Bearings. Check sleeve bearings for babbitt dragging or high spots. Then you might have to spot to shaft journals. Split bearing shells tend to spread out at joint when removed from bearing housing. So it's impractical to measure them without holding rings used in their manufacture. Use bearing housing instead of holding rings. Place four or five pieces of lead wire between top of journal and bearing. Then bolt bearing cap. Wire flattens in clearance space. Remove bearing cap and micrometer thickness of flattened wire.

Thrust bearing's failure can wreck internal parts by rubbing them against each other. *Dismantle bearing complete*ly and inspect grooved or pitted thrust surfaces. Refinish if practical. Otherwise, renew parts. Inspect all oil passages. Install parts in right location and adjust clearances with shims.

Running clearance is space between rotating thrust collar and stationary thrust face. In Kingsbury thrust, housing is normally in bearing bracket with adjustable tongue and groove. There's clearance between these parts and threads on adjustable tongue and housing block to prevent movement when setting running clearance between thrust faces. Caution! I've seen turbines damaged seriously because thrust bearing was assembled incorrectly.

Coupling. Well-designed turbine has enough thrust-bearing capacity to absorb turbine thrust loads, but not extra thrust from other machines. So turbines are usually connected to driven unit through flexible coupling. Dismantle coupling at each inspection and check thoroughly. Look for wear, shoulders and galled surfaces that transmit torque. Such conditions reduce flexibility. Then thrust from driven unit may be transmitted to turbine. Clean coupling and replace worn parts.

Vibration from coupling may cause fatigue failure in rotor. That might even break shaft or wheel disks, so check alignment.

Governing System. Governor keeps uniform steam flow to turbine for right speed regulation. Dismantle governor at each inspection, check for worn or *broken parts, also lost motion* and friction in transmission. Replace all questionable parts. When taking apart, note settings of all adjustable elements.

When reassembling, check all parts for tendency to bind. Stone or crocus-cloth such parts. Don't polish governor parts too much, or you'll have lost motion.

Governor valves are directly controlled by governor, either mechanically or hydraulically. In either case, freely operating valves are important. During inspection, renew packings on steam chest or on hydraulic system. Use right packing. Check all rods for straightness and smoothness. Tight packing glands have caused valve rods to bend and gall from force transmitted by governor.

Emergency Governor. *Overspeed governor* prevents dangerous overspeeding. This trips either throttle valve or an emergency stop valve, shutting off steam when turbine reaches 110% of rating. Give this device as much attention as boiler safety valve or any other safety device.

If test shows that governor doesn't work right, shut turbine down immediately. At inspections, examine governor and tripping mechanism, including valve. When reassembling overspeed device, test tripping mechanism by hand before admitting steam to turbine. Check governor operation several times by overspeeding turbine to design tripping point. Use tachometer for overspeed test.

Corrosion. Serious cause of corrosion during idle period is improper seating of sealing, drains, throttle and header valves. They allow steam to leak into turbine to condense. Regrind or renew if renewable type, test for tightness.

Circulate oil through unit a few minutes every day. While circulating oil, turn unit through 1¼ revolutions so bearing surfaces are oiled and rotors come to rest in new positions.

Factory Service. Best man to inspect a turbine and supervise its repairs is usually manufacturer's service man. He's not a cure-all, but he is backed by factory's engineering department. That makes cost of his services a good investment.

But whatever you do, don't expect trouble-free service from your turbine, *year after year, just because it keeps* running. Follow suggestions given here.