

The Forge: Building a Forced-Air Solid-Fuel Forge from Salvaged Materials

Companion piece to the field-metallurgy document — the heat source needed to work the salvaged steel that spark testing, Curie-point checks, and EN 10027 identification have sorted.

TL;DR

Build a side-blast JABOD ("Just A Box Of Dirt") forge for charcoal and a brake-drum/firepot bottom-blast forge for mineral coal — these two designs cover the full range of scavenged-material availability, cost roughly \$80 new (or half that scavenged), and can both reach forge-welding heat (~1200–1300°C) given adequate air.

Air-delivery geometry must match the fuel: charcoal wants a shallow, wide, side-blast fire with a small tuyere ($\frac{3}{4}$ –1" / 20–25 mm ID) because it is light, porous, and burns through its whole mass; mineral coal wants a deep bottom-blast firepot (~3–4" deep, 7–8" total fire depth) where volatiles cook off into coke and clinker collects below the air blast.

The single biggest killer is carbon monoxide — never run a charcoal or coal forge in an enclosed space (OSHA PEL 50 ppm 8-hr TWA; NIOSH REL 35 ppm; a 60-minute exposure near 400 ppm is an emergency exposure level and higher concentrations can kill within an hour or less). Never use galvanized pipe for a tuyere (zinc fume fever), and wet-work all clay/sand/grog to avoid respirable crystalline silica.

Key Findings

Two builds cover the field. The JABOD side-blast is the fastest, lowest-material forge — Charles R. Stevens of I Forge Iron reports a working box-of-dirt built in about 4 hours from a wooden box, dirt/clay, a length of $\frac{3}{4}$ " black pipe, and an air-mattress inflator. The brake-drum bottom-blast is the classic coal forge, built from a salvaged cast-iron drum, 2" black-iron plumbing, and a hair dryer or squirrel-cage blower for roughly \$80 in new parts (Argobuilder).

Charcoal and coal are not interchangeable in the same firepot. Charcoal in a deep bottom-blast pot throws sparks, burns fast, and burns the stock; coal in a shallow open side-blast trench will not coke or concentrate heat well. The geometry is dictated by fuel physics, not preference.

Air pressure matters more than raw CFM. The traditional standard (Blacksmiths Depot / Kayne & Son) is that the blast should "levitate the coal." Squirrel-cage and axial fans move volume but lack static pressure; a real blower or a manual bellows delivers pressure. Too much air wastes fuel and scales/burns the steel — throttling with a gate or bleed valve is essential.

Refractory is optional in a solid-fuel forge but useful for shaping and shell protection. A clay + sharp sand mix (roughly 1:2 to 1:3) with grog controls shrinkage cracking. Natural subsoil clay can be field-tested with the ribbon test and jar/settling test. Firing must be slow to avoid steam spalling.

Manual air supply is entirely achievable from scrap. The double-lung great bellows, the Japanese fuigo box bellows, and improvised centrifugal blowers from salvaged HVAC/car-heater parts all work. The fuigo is exceptionally well suited to scrap-wood construction and to charcoal.

Details

1. Forge Typology and Selection

Forge type	Air delivery	Best fuel	Scavenge-ability	Fuel efficiency	Reaches welding heat?	Key to success
JABOD side-blast	Side tuyere through a dirt/clay wall	Charcoal (also soft coal)	Excellent — box, dirt, one pipe	High with charcoal	Yes, with adequate air	Tuyere back; periodic daubing
Traditional side-blast trench	Side tuyere at ground level	Charcoal	Excellent — literally a trench	High	Yes	Low, ground level with height
Brake-drum bottom-blast	Up through drum center	Mineral coal	Good — drum is common scrap	Moderate; often too deep/shallow	Yes	Drum rarely needs
Firepot bottom-blast (purpose-built)	Up through cast firepot	Bituminous coal/coke	Fair — needs a real firepot	Best for coal	Yes, easily	Harder source

Forge type	Air delivery	Best fuel	Scavenge-ability	Fuel efficiency	Reaches welding heat?	Key t
Washtub / wheelbarrow forge	Bottom or side	Coal or charcoal	Good — the tub is the hearth	Moderate	Yes	Thin s out wi lining

Why the geometries differ. Charcoal is roughly one-tenth the density of bituminous coal (bituminous SG ~1.27; charcoal ~0.13 average, [Anvilfire](#) per anvilfire). It is porous and light, so the whole mass of fuel above the tuyere reacts and the fire spreads readily; [iforgeiron](#) it does not need a deep concentrated blast. Charles R. Stevens' guidance is a brick-sized fire bowl (~8" long × 4" wide × 2" deep) [I Forge Iron](#) with a ¾–1" ID tuyere, 1" of space below the tuyere for ash, and 3–4" of fuel above it. A large tuyere and deep pot waste charcoal. For long or large stock in charcoal, practitioners use **multiple tuyeres spaced 5–6" apart** along a trench or around a bowl [iforgeiron](#) rather than one big blast.

Mineral coal, by contrast, benefits from a deep bottom-blast firepot: the wet coal banked around the fire smolders, drives off volatiles, and forms coke that migrates to the heart of the fire, [sustainlife](#) while clinker (fused silica/ash/iron oxide) sinks below the blast where it can be raked out. Beautiful Iron documents a **typical general-smithing fire as 7–8" total depth** — roughly 3" of firepot below the hearth plus coal mounded ~1.5" above, [beautifuliron](#) with the air converging ~2" above the tuyere in the "heart" of the fire.

Brake drums are a compromise, not an ideal. Beautiful Iron's polemic "Brake Drum Forges Are JUNK!" argues (as an editorial stance) that a truck drum is both too deep and too straight-walled to make air converge like a purpose-built firepot, and that the money spent modifying it is better spent on a real firepot. [Beautifuliron](#)

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The counter-view from working smiths (BladeForums, I Forge Iron) is that a drum, or a refractory-lined mild-steel pot, works fine for years. Both are true: a drum is an excellent free starting point but rarely has ideal geometry, and is usually built up in the center with refractory or mounded with coal.

2. Firepot / Firebox Geometry and Dimensions

General-smithing firepot (coal): bowl-shaped, round or square, tapering inward to the bottom, **2-6" deep with 3-4" most practical** (Beautiful Iron). Deeper is only for large stock. The heart of the fire sits half above/half below the hearth line; the work must pass through that heart without being bent — the "first rule of forge design." Set the hearth at about anvil height (Beautiful Iron cites ~31½" — knuckle/second-finger-joint height for the smith).

Charcoal fire bowl: ~8 × 4 × 2" (a "brick to the square"), tuyere ¾-1" ID, 1" below tuyere for ash, 3-4" of fuel above.

Fire zones (bottom to top through the blast column):

Oxidizing zone — immediately at/above the air inlet, oxygen-rich; steel left here scales and burns. This is why stock is never placed right at the tuyere mouth.

Neutral zone — just above, where combustion is balanced.

Reducing zone — the carbon-rich region above, where excess CO scavenges oxygen; this is where you heat steel to protect it from scaling and where forge welding is done.

Tuyere sizing and placement:

Side-blast (charcoal): $\frac{3}{4}$ –1" (20–25 mm) ID; positioned so the fuel bed gives ~1" below and 3–4" above the tuyere; angled slightly downward toward the fire to push the hot center out away from the tuyere wall (Stevens). [I Forge Iron](#)

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45 mm ID is too large for charcoal — it will heat 6" of stock with coal and a strong blast, [iforgeiron](#)

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but wastes charcoal.

Bottom-blast (coal): 2–3" pipe is standard; post-Civil-War coal-forging tables scale tuyere size to stock size.

Cooling: side-blast tuyeres run hot and burn back. The British "Alcosa"-style forges use a **water-cooled cast-iron tuyere** bolted through a water tank at the back of the hearth (gaskets seal the tuyere through both tank walls so water circulates around the air passage). [Beautiful Iron](#)

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Simpler options with historical precedent: a **clay tuyere** (potter's stoneware or clay rammed around a core), [beautifuliron](#)

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a **soapstone bellows-stone** (natural refractory good to ~3500°F), or a forged **wrought-iron tuyere** (Colonial Williamsburg / Frontier Culture Museum research — durable and smith-made, though "we've burned up quite a few of them" while learning). Many primitive African side-blast forges simply aim a bare pipe at the fire and accept burn-back.

NEVER galvanized: heating zinc-coated pipe near the fire releases zinc oxide fume (zinc fume fever). Use black iron pipe only.

Ash dump / clinker breaker (bottom-blast): below the firepot air hole, a tee in the plumbing runs down to a threaded cap = ash dump (fines fall through; cap unscrews to clear — smear high-temp grease on the threads so it doesn't rust solid, or better, fit a hinged lid). [Life's Forge](#)

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A **clinker breaker** — a triangular or elliptical bar (ideally cast iron so it

doesn't burn or weld to clinkers) [Blacksmiths Depot](#)

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— sits in the air hole, supports fuel from falling through, directs air, and rotates to loosen clinker. [beautifuliron](#)

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DIY substitutes: a cast-iron floor drain grate, or a 3" pipe cap drilled with ¼" holes. Never pour water on a hot cast-iron firepot — thermal shock cracks it. [beautifuliron](#)

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3. Refractory Lining from Scavenged Materials

Solid-fuel forges do not strictly need refractory (unlike gas forges)

because the fuel bed itself insulates the shell; the lining's job is to give the firepot its shape and protect a thin steel or wooden shell. [Tapatalk](#)

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Clay/dirt is entirely adequate.

Finding and testing clay:

Ribbon test: moisten a golf-ball of subsoil, roll into a coil, press between thumb and forefinger into a ribbon. A ribbon exceeding ~2" before breaking = high clay; [Biology Insights](#)

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a ribbon under 1" or that crumbles = loam/sandy; no ribbon = sand. A 5–6" ribbon is near-pure clay. [Biology Insights](#)

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Feel test: sand is gritty, silt is smooth/floury, clay is sticky/plastic. [Colorado Master Gardener](#)

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Jar/settling test: fill a straight-sided jar 1/3 with sifted soil, add water + a pinch of detergent, shake, let settle. Sand drops in ~1 minute, silt in ~2 hours, clay over 24–48 hours, forming visible layers whose proportions you measure. [Growit Buildit](#)

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[Clemson HGIC](#)



This tells you the clay:silt:sand ratio so you can adjust temper.

Refractory/lining mixes (by volume):

Mix	Ratio (by volume)	Notes / service behavior
Clay + sharp sand	1 : 2 to 1 : 3	Standard forge daub; sand/grog controls shrinkage cracking
Clay/fire clay + grog (crushed fired brick)	1 : 3 grog/sand	Grog is pre-fired so it doesn't shrink again — best crack control
Fire clay + sand + perlite	1 : 2 : 1	Adds insulation; perlite lowers max service temp
Clay + wood ash	~1 : 1 field mix	Ash acts as filler/flux; traditional
Clay + straw / horse manure	organic ~30–35% by volume	Organic temper burns out leaving vent channels that reduce steam spalling; the "cob/adobe" JABOD approach

Grog and sand work because clay shrinks as it dries and again as it vitrifies;

BigCeramicStore.com



non-shrinking aggregate (pre-fired grog, or quartz sand) forms a skeleton that resists cracking [My Blog](#)



and opens channels for water vapor to escape. Aim for grog/sand roughly the texture of coarse sand. [ScienceInsights](#)



Service temperatures: ordinary fire clay alone handles roughly 1350°C (2460°F); with high-alumina aggregate (mullite/bauxite) that ceiling rises

toward 1700°C (3090°F). [ScienceInsights](#)



Calcium-aluminate refractory cement handles ~1350°C on its own.

[ScienceInsights](#)



Perlite/vermiculite mixes insulate well but soften at lower temperatures — keep them off the hot face. For a solid-fuel forge these limits are academic since the fuel bed, not the lining, contains the heat.

Salvaged industrial refractory: split firebrick, night-storage-heater bricks, old boiler/kiln brick, chimney liners, wood-stove firebrick, and cut-down hard firebrick all make excellent firepot walls (better than clay because you can't accidentally rake through them). **Salvaged ceramic-fiber blanket** is a serious hazard: after service above ~1800°F it partly devitrifies to **cristobalite (crystalline silica, IARC carcinogen)**; [The Home Depot](#)



new blanket sheds respirable fibers (typical manufacturer exposure guidance ~0.5 fibers/cc, 8-hr TWA). If used, it must be coated with a rigidizer (colloidal/sodium/potassium silicate, ~2–6 lb per cubic foot of fiber) and never left exposed on a hot face you will disturb.

Drying and firing schedule (critical):

Air-dry the lining until bone dry — days to weeks depending on climate and thickness. Poke deep vent holes with a coathanger to speed and even the drying. [Tapataalk](#)



Water-smoking (free water): first firing, hold gently at ~80–100°C (176–212°F) for a few hours to drive off free water below boiling. [Ceramic Arts Network](#)



Chemically bound water: ramp slowly through ~250°C. Typical safe ramp for castables/thick clay is **25–50°C/hour**, with holds at ~110°C (free water) and ~250°C (bound/hydrate water). [Bloorengineering](#)



Consequence of rushing: water turning to steam expands ~1600× in volume; trapped steam spalls or explosively pops chunks off the lining. [HWI](#)

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Keep people clear during first fire and ensure ventilation for the vapor.

Repair/maintenance: patch cracks with fresh wet daub after each few sessions; a dirt/clay JABOD lining is essentially consumable and re-formed as needed. A well-made clay firepot lasts a season of regular use; salvaged firebrick lasts far longer; a good cast-iron firepot can last 20+ years.

[beautifuliron](#)

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4. Manual Air Supply — Bellows and Blower Design

Double-lung "great" bellows (European, 18th c.): two stacked chambers. The lower chamber, worked by the lever, forces air through leather-and-wood flapper check valves into the upper chamber; the upper chamber, weighted by stones or hung weights on the top board, discharges a **steady** blast through the nose pipe while the lower one refills. [beautifuliron](#)

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This overlap converts pulsed pumping into continuous air. Practitioner construction notes: leather (or cloth-reinforced rubber/vinyl) side walls; hide ~2.5–3.5 mm thick, seams copper-nailed on ~25 mm pitch; a mid-chamber wooden rib/spreader riveted inside to stop the leather ballooning;

[beautifuliron](#)

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valves faced with felt or an old washcloth for a soft seal, hinged with thin leather; [Blogger](#)

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the opening width should at least equal the widest part of the bellows.

[Blogger](#)

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A traditional example (per a how-to based on a rebuilt Agricultural Museum bellows) is about **5 feet long**. [Pieh Tool Co](#)

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Weighting the top board sets pressure and velocity. Fit a light backflow

valve (a ping-pong ball works) to guard against fire-gas blowback into the leather. [Blogger](#)



Steady output holds pressure to within a few percent at organ-wind levels — the same principle blacksmiths exploit for an even fire.

Single-chamber (single-acting) bellows delivers air only on the compression stroke, so the blast is **pulsed** — fine for a bloomery-style intermittent fire but poor for steady work. Historically used in pairs (Viking/medieval), the smith alternating them by hand or foot to approximate continuity.

Japanese fuigo (box bellows): a rectangular wooden box with a piston sealed at its edges with fur (raccoon, badger, rabbit), [Never Stop Building](#)



feathers, or soft cloth, and four wooden flap valves (*ben*). Pulling and pushing the handle both deliver air (double-acting) — air is drawn through one flap while pushed out the other on each stroke, so the blast is nearly continuous except at direction changes. [Never Stop Building](#)



The bottom is often lined with glass to smooth piston travel; [Never Stop Building](#)



valves are covered with washi paper for a tight seal; side panels ~9 mm cedar, bowed slightly inward to resist air pressure. [Blogger](#)



The form was finalized by ~the 6th century. Advantages that make it ideal for a low-infrastructure charcoal shop: built almost entirely of scrap wood; air stops instantly when you stop (saves fuel while you're at the anvil); strong restart blast that feathers down in seconds; no leather or electricity needed.

Chinese double-acting piston box bellows is the ancestor of the fuigo: a piston in a rectangular (or cylindrical) box with edges sealed by feathers/fur/paper, flap valves pumping air on both in- and out-strokes.

[National Park Service](#)



The Han Chinese applied water-wheel power to such piston bellows for iron-working by the 1st century (Du Shi, d. 38 CE). [En Academic](#)



Rotary hand-crank blacksmith's blower: the best hand option if you can salvage one from an old forge. Good blowers are ~10–12" case diameter with **long impeller blades** (the long paddles create the static pressure needed to overcome fire and duct resistance) and gear/pulley step-up so ~½ crank-revolution per second gives a strong blast. [beautifuliron](#)



Inspect used blowers for smooth cranking, intact gears/blades, and an oil-fillable gearbox; counterintuitively, a properly connected blower is *harder* to crank because it is doing real work moving air against resistance.

Improvised centrifugal blowers from scrap (in rough order of suitability):

HVAC squirrel-cage furnace/boiler blower, car heater blower motor, "fart-fan" bathroom extractor — usable, moderate pressure; a ~140 CFM squirrel cage is a common working figure, throttled with a waste gate. [tractorbynet](#)



Vacuum-cleaner blower — strong but very loud.

Hair dryer (heating element optional) — the classic \$12 brake-drum-forge blower; two speeds give crude control.

Computer/axial fans generally FAIL — they move volume at almost no static pressure and cannot push air through a fuel bed. Beautiful Iron is emphatic that short-bladed squirrel cages and axial fans "won't develop enough pressure no matter what diameter they are."

Hands-free drives: bicycle-wheel/flywheel hand-crank rigs and treadle drives free both hands for the work; a flywheel smooths a treadle's pulses.

Air volume/pressure figures: commercial electric forge blowers run on the order of ~125 CFM at ~380 Pa [Amazon](#)



up to ~300 CFM at ~780 Pa. A small charcoal JABOD needs far less — an air-mattress inflator or a throttled hair dryer suffices. The governing principle: **pressure to "levitate the coal," not maximum CFM.** [Blacksmiths Depot](#)

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Too much air is "the bane of charcoal" (Stevens) [I Forge Iron](#)

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and burns/scales steel in coal.

Throttling and ducting: always regulate with a **gate/butterfly valve or a bleed (waste) tee** downstream, or by restricting the blower *intake* — not by hard-choking the blower outlet (a blocked blower over-revs and, if electric, may overheat). [beautifuliron](#)

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Stevens uses a $\frac{3}{4}$ " ball valve plus a tee that bleeds excess air (also quieter).

[iforgeiron](#)

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Duct with black iron pipe sized to the tuyere (2" typical for coal, $\frac{3}{4}$ –1" for charcoal); short runs and few bends preserve pressure.

5. Fuel

Charcoal. Make it by pyrolysis in a sealed vessel: the **barrel/retort method** (a 55-gallon drum with a well-fitting lid and a 2" bung; [Charcoalkiln](#))

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or a small inner drum nested in a larger drum with scrap wood burned in the annular gap to "cook" the good wood without consuming it — the Bessemer-era indirect method). A tilted-barrel or top-lit method yields roughly 60% charcoal when done well; a crude open barrel gives about 1/3 good charcoal, 1/3 over-burned ash, 1/3 under-cooked. [Blogger](#)

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Retorts burn the wood gas to heat the charge and emit almost no smoke.

[Jeffreyfunkmetalworker](#)

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Crush/size charcoal to roughly lump-coal size for the forge. Charcoal burns fast and needs a deeper/wider fire and constant air; by weight it has nearly the same fuel value as coal, but because it is ~1/10 the density you need

roughly 8–10× the volume of charcoal to do the same work (anvilfire;

[Anvilfire](#)

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one farrier estimates only ~2×, the discrepancy stemming from assumed density — treat 8–10× as the conservative planning figure). **Avoid**

briquettes: clay/starch binders and fillers make clinker and lower heat; use lump only.

Mineral coal. Three ranks matter:

Bituminous ("smithing coal") — the coal of choice. Soft, mid-grade, low sulfur; [HubPages](#)

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its volatiles cook off in the banked wet coal to form **coke** that sticks in large chunks, burns clean and hot, and shields the eyes. Premium blacksmithing bituminous from the Pocahontas No. 3 seam (low-volatile bituminous, WV) analyzes per anvilfire's Penn State-sourced figures at **0.64% sulfur, 7.44% ash, 15.70% volatile, 92.42% fixed carbon, 14,542 BTU/lb** — but anvilfire warns "not all Pocahontas coal is the same" (a Virginia sample = 15,006 BTU, another WV lot 13,953). An independent lab report of a commercial smithing-coal lot (GeoChemical Testing, Somerset PA) lists 0.75% sulfur, 7.12% ash, 14,373 BTU/lb, and a Free Swelling Index of 9 (strongly coking).

Anthracite ("nut/hard coal") — cleanest and highest BTU (~86–98% carbon, >30 MMBTU/ton), [uspto](#)

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[uspto](#)

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but **dense and hard to keep lit:** it needs continuous forced air, won't smolder or idle between heats, is slow to bring to heat, [uspto](#)

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and its small coke fragments blow out of the fire. Works only with a powered blower left running, not a hand crank left idle. In the U.S. it is confined to the anthracite region of northeastern Pennsylvania — essentially six counties (Carbon, Columbia, Lackawanna, Luzerne,

Northumberland, and Schuylkill, plus a sliver of Dauphin), some ~480 square miles across four fields.

Lignite/household coal — softest, highest ash and sulfur, worst clinker; poorly suited to forging.

Coking behavior and clinker: good bituminous is banked wet around the fire; volatiles burn off, leaving coke that migrates to the center. **Clinker** is the fused, non-combustible mineral residue (silica + ash + iron oxide) that collects below the blast and, untended, blocks air and steals heat — old-timers called it "a thief." Sulfur lowers coke quality and can embrittle thin, long-soaked steel; the anvilfire guru's nuance is that for ordinary forging (as opposed to smelting ore) modest sulfur is largely tolerable — but low-sulfur bituminous is still preferred.

Coke (bought or salvaged from gas-works/cement plants) burns very hot and clean but **must** have a powered blower — a coke fire dies the instant the blast stops, so it is incompatible with hand bellows left idle. Heavy foundry coke is generally too dense for forge use. [Anvilfire](#)

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Wood is a poor last resort — a working smith reports burning ~10–15 lb/hour of wood for an inferior fire; use it only to make charcoal.

Where to scavenge coal: surface coal-seam outcrops and old mine tailings (historically coal was "picked up from the ground" at outcrops); abandoned-mine districts; feed/farm stores selling broken bags of stoker/heating coal; industrial coke byproduct (with caution). Bituminous dominates east of the Mississippi and the mid-continent fields; anthracite only in NE Pennsylvania; lignite in Texas/the Dakotas/Montana.

Comparative performance:

Fuel	Max forge temp	Consumption (typical)	Air source	Clinker
Bituminous coal	~3500°F/1927°C ceiling (coal gas burns ~3590°F at 100% air, per Marks' Handbook)	~1.75–2.5 lb/hr small work; ~6–12 lb/weekend; ~600 lb/yr hobbyist	Hand or powered	Moderate; low with good coal
Anthracite	Very hot, clean	Similar by weight; harder to sustain	Powered only	Fused silica "glass" clinker in dirt forges
Charcoal	Comparable to coal (near iron-melting)	~8–10× coal by volume; ~30-gal barrel/day	Hand or powered	Very little (clean)
Coke	Very hot, clean	Similar to coal	Powered only	Low
Wood	Low/inconsistent	~10–15 lb/hr	Any	High ash

6. Assembly Sequences

Build A — JABOD Side-Blast Charcoal Forge (fastest, lowest material)

Tools: saw, drill, hammer/screwdriver, something to dig/tamp dirt. **Build**

time: ~4 hours from first board cut to first fire. [I Forge Iron](#)



Materials: a wooden box (or salvaged sheet-metal box, washtub, or half-barrel) ~24" square × ~7–8" deep; [I Forge Iron](#)



subsoil clay/dirt; ~2–3 ft of $\frac{3}{4}$ " black iron pipe (tuyere); a $\frac{3}{4}$ " ball or gate valve; an air-mattress inflator, hair dryer, or salvaged blower.

Build/scavenge the box. 1×8 lumber or pallet wood, ~24" square. [I Forge Iron](#)

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If wooden, plan ≥ 2 " of dirt/clay between fire and any wood face (thicker is safer). Substitute: steel drum half, washtub, wheelbarrow tray, or a dug trench in the ground (no box at all).

Fill with dirt/clay and tamp firm. Build the level up to working height.

Set the tuyere. Lay the $\frac{3}{4}$ " pipe horizontally so its mouth is at the future fire wall. Measuring up from the box floor: ~2" of clay, then the tuyere so there is ~1" below it (ash sump) and ~4" of fuel depth above it to the hearth surface. [DCNZ](#)

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Angle the pipe slightly downward toward the fire center.

Form the fire trench/bowl in the packed dirt: ~8" long × 4" wide × 2" deep, with a 12–16" back wall [I Forge Iron](#)

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and short side walls 3–4" high to contain charcoal. Pack the clay around the tuyere mouth; leave the pipe end flush or just proud of the wall.

Plumb the air. Connect the blower to the pipe with the ball/gate valve inline; add a bleed tee if the blower is strong. Never galvanized.

Dry it. Air-dry the daub until bone dry (days). Poke vent holes.

First fire — slow. Light a small wood fire in the bowl and hold it low for the first hour or two [Tapatalk](#)

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to water-smoke the clay (drive off free water below 100°C) before running hard. Then add charcoal, open the air gently, and bring to heat. Expect to re-daub the tuyere wall periodically as it burns back.

Substitution ladder: box → tub → trench; $\frac{3}{4}$ " black pipe → any ~20–25 mm steel tube; inflator → hair dryer → hand-cranked blower → fuigo box bellows.

Build B — Brake-Drum Bottom-Blast Coal Forge

Tools: drill, wrenches/pipe wrench, saw or angle grinder, tap for thumb-screws (optional). **Build time:** a few hours to a day. **Materials (per the well-documented Argobuilder build):** cast-iron brake drum (~9" ID × 2" deep, or a deeper truck drum); two 1×1×36" steel angles; 2" **steel** (never galvanized) threaded floor flange; 2" pipe nipples (one ~5", two ~6") threaded both ends; a 2" threaded tee; a 2" threaded end cap; four ¼" nuts/bolts; two ¼" thumb-screws; a grate (stainless offcut, cast-iron floor drain, or drilled pipe cap) to cover the center hole; a full-size two-speed hair dryer or ~140 CFM squirrel-cage blower. Total ~\$80 new, ~half scavenged.

Source and clean the drum. A passenger drum (~9" ID, 15–25 lb) is fine; truck drums are deeper (often too deep — plan to build up the center with refractory or mound coal). Cast iron is preferred: high thermal mass, resists burn-through and oxidation, distributes heat evenly (wall ~¾" thick). Refractory-lined mild steel also works if no drum is available, but scales/burns faster at the air hole and needs a ¼–½" clay coat.

Build the stand/legs. Bolt the two steel angles across the top of a salvaged steel stand or weld three legs; the drum rests on/between the angles. Tap ¼" thumb-screws to lock the drum to the angles.

Bolt the flange to the drum bottom. Drill four ¼" holes around the center hole, bolt the 2" floor flange over it. The center hole is the air inlet/ash path.

Assemble the plumbing (tee below the drum): flange → 6" nipple down → 2" tee. The tee's side branch (6" nipple) is the horizontal air inlet from the blower; the tee's bottom (5" nipple) runs down to the threaded end cap = **ash dump** (unscrew to clear fines; grease the threads or fit a hinged lid so it doesn't seize).

Fit the grate/clinker breaker over the center hole inside the drum so air passes up but coal doesn't fall through. A rotating cast-iron breaker is ideal; a drilled 3" pipe cap or cast-iron drain grate is the scavenger's version.

Add an air gate. Inline gate/butterfly valve or a sliding-plate air dam just below the drum, and/or a bleed, to throttle the hair dryer/blower. Regulate air here, not by choking the blower outlet.

Optional refractory build-up. If the drum is too deep or straight-walled, line/build up the center with clay+sand+grog or perlite+furnace-cement to form a proper bowl ~3-4" deep tapering to the grate. Dry and slow-fire per Section 3.

First fire. Prepare dry hardwood kindling (4-6") and paper. Light paper in the center, add kindling, start the blower on low, then bank coal over the fire and bring the air up to coke the coal. Keep wet coal banked at the sides; rake clinker from below the blast as it forms.

Substitution ladder: brake drum → brake rotor (weld center back in) → refractory-lined steel washtub/pan → purpose-built cast firepot; hair dryer → squirrel cage → hand-crank blower.

7. Safety (integrated — the source document already flags these)

CARBON MONOXIDE — the single biggest killer. CO is colorless and odorless. OSHA PEL is **50 ppm (8-hr TWA)**; [US EPA](#)

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NIOSH REL is **35 ppm TWA with a 200 ppm ceiling**; NIOSH lists a 60-minute Emergency Exposure Guidance Level of **400 ppm**, and higher concentrations can incapacitate and kill within an hour or less. Charcoal is especially insidious because it burns with little smoke to warn you. **Never run a solid-fuel forge in a closed garage, shed, or tent.** Forge outdoors or under an open-sided roof with cross-ventilation and a chimney/hood; fit a CO alarm. This hazard alone has killed people using charcoal indoors for heat.

Zinc fume fever. Never use galvanized pipe, buckets, or sheet for the tuyere or anywhere near the fire. Heated zinc coating vaporizes to zinc oxide; [Fumextractors](#)

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inhalation causes flu-like fever, chills, nausea, and metallic taste 4-10 hours later. [Henlex](#)

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OSHA PEL for zinc oxide fume is **5 mg/m³** (8-hr). Use black iron pipe. (The source document covers this — reinforced here: strip or avoid all plated/galvanized scrap.)

Respirable crystalline silica. Clay, sand, grog, firebrick dust, and especially after-service ceramic-fiber blanket (which devitrifies to cristobalite above ~1800°F) [The Home Depot](#)

are IARC-listed carcinogens. **Wet-work and wet-sweep; never dry-grind or use compressed air to clean;** [Unitherm](#)

wear a NIOSH-rated respirator (N95 minimum, better P100) when crushing grog or handling fiber.

Burns, eyes, scale, hot-short scrap. Wear thick 100% natural fiber (cotton/wool) or leather — synthetics melt to skin. Safety glasses against flying scale and infrared; the heart of a coal fire emits harmful light, so keep it capped with coke. Hot-short (high-sulfur/phosphorus) scrap can crumble or spit under the hammer.

Fire safety and siting. Site on non-combustible ground with generous clearance from anything flammable; keep water/sand and a rake at hand; beware the ~5' plume of sparks a strong blast throws.

Plated/painted/alloy scrap. Never burn or overheat chromium-plated, cadmium-plated, lead-bearing, or painted scrap in the fire — chromium (VI), cadmium, and lead fumes are acutely and chronically toxic. Cadmium fume in particular can be lethal. Strip coatings, and identify unknown plating before it goes near the heat.

8. Quality Checks and Troubleshooting

Reading welding heat by color (mild/low-carbon steel):

Dull/dark red (~650–700°C) — finish forging, straightening only.

Full/bright red (~800–900°C) — general forging of alloy steels.

Yellow (~1000–1100°C) — forging mild steel/wrought iron.

Light yellow to yellow-white with the first sparks (~1200–1300°C; bright yellow ~2200–2400°F) — forge-welding heat for mild steel; flux looks wet and "slippery," then the surface goes bright and sparks fly. Remove and strike immediately; stop welding as it drops back to light yellow.

White/sparkling ("sizzling") — too hot; the steel is burning and being destroyed. Alloy content and grain are ruined.

Reading a charcoal fire by flame: flames run blue → blue-and-orange → yellow → bright yellow-white as the fire heats; welding heat is reached about when the blue flames stop.

Reducing vs oxidizing fire. A **reducing** (carbon-rich, air-starved) fire is what you want for welding and to protect steel: keep a deep bed of coke/charcoal over the work so excess CO scavenges oxygen. An **oxidizing** fire (too much air, or work sitting at the tuyere mouth) scales and burns the steel and prevents welding. If you're making "adult sparklers," you have too much air and/or too little fuel depth over the work.

Common failure modes and fixes:

Cracked lining — wet clay fired too fast (steam spalling) or thermal shock/water on hot cast iron. Fix: slow dry-out, add grog/sand and organic temper, [Tapatalk](#)

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never quench a hot pot.

Burnt-out tuyere — inevitable on side-blast; use water-cooled, clay, soapstone, or forged wrought-iron tuyere; re-daub clay walls; accept periodic replacement.

Insufficient fire depth — work not passing through the reducing heart; deepen/mound the fuel so there's 3–4" over the work.

Too much air — wasted fuel, scaling, "sparklers"; throttle with a gate/bleed valve; for charcoal use a small tuyere and gentle blast.

Wet fuel — steam, spitting, poor heat; dry fuel first (but note wet coal is deliberately banked at the *sides* to coke).

Clinker choking the tuyere/air hole — heat drops, fire won't build; rake/lift clinker with the clinker breaker from below the blast, clear the ash dump, and for anthracite in a dirt forge expect fused "glass" clinker.

Recommendations

Start with the JABOD side-blast if you have charcoal or wood, or a brake drum + coal if you have those. Match the build to the fuel you can actually scavenge, not the other way around. If you have neither coal nor a drum, dig a trench side-blast and make charcoal — this is the lowest-infrastructure path and can be running in an afternoon.

Invest your scavenging effort in the air source and the tuyere, not the hearth. The hearth is just dirt or a drum; the blast and its control determine whether you reach welding heat. Prioritize salvaging a hand-crank blower or building a fuigo; failing that, a car-heater/HVAC squirrel cage. Always fit a gate or bleed valve.

Fuel priority: bituminous smithing coal > coke (with powered blower) > lump charcoal > anthracite (powered blower only) > wood (make charcoal from it). If you can only get anthracite or coke, commit to a reliable powered blower because these fuels die the instant the blast stops.

Refractory only if you need shape or shell protection. Use clay + sharp sand 1:2–1:3 with grog; salvage firebrick where possible; dry slowly and first-fire gently.

Non-negotiable safety kit before first fire: open-air or hooded/ventilated siting + CO alarm; black-iron-only tuyere; P100/N95 respirator for clay/grog/fiber; natural-fiber clothing and eye protection; water/sand on hand.

Benchmarks that change the plan:

If you cannot reach yellow-white/sparking heat, your problem is almost always **air pressure** (not CFM) or **fire depth** — upgrade the blower or

deepen the fuel before rebuilding the forge.

If steel keeps scaling/burning, you have an **oxidizing fire** — cut air and deepen the coke/charcoal over the work.

If the fire keeps going out between heats, you're likely on **anthracite or coke without continuous air** — switch to bituminous/charcoal or add a powered blower.

If the lining spalls or cracks on first fire, your **dry-out was too fast** — restart with a longer air-dry and a gentler ramp.

Caveats

Numbers vary by practitioner and are often approximate. Firepot depths (2–6"), tuyere sizes, and especially the charcoal:coal volume ratio (anvilfire ~8–10× by volume; some smiths ~2×) are working estimates, not laboratory values; the discrepancy comes from differing assumed charcoal densities. Treat all dimensions as starting points to be tuned by experiment (Stevens' own method: build, fire, observe, modify, repeat). [iforgeiron](#)

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The brake-drum "junk" debate is partly editorial. Beautiful Iron's strong stance against brake drums reflects a preference for purpose-built cast firepots; many working smiths get years of service from drums and refractory-lined steel. Both positions are represented above.

The sulfur-in-coal question is contested. Teaching institutions treat sulfur as a real problem; the anvilfire guru and some coal-burners argue it matters mainly in smelting ore, not general forging. [Coalpail](#)

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Prefer low-sulfur bituminous when you can (~0.6–0.75% is typical premium smithing coal), but don't discard usable higher-sulfur coal on that basis alone.

Temperature/color correlations are for mild/low-carbon steel and shift with alloy and ambient light; the field document's Curie-point and spark-

test methods remain the more reliable steel-ID tools. Use color for fire management, not precise metallurgy.

Water-cooled tuyeres carry their own risk: a breach that lets water into a hot fire can flash to steam violently. Keep cooling water systems sound and never let a dry-running cooled tuyere overheat.

Several dimensional and consumption figures rest on forum practitioner reports (I Forge Iron, BladeForums, TractorByNet, Argobuilder) rather than formal literature; they are consistent across independent builders but should be understood as craft consensus, not published standards.