

Restoration Note

Cincinnati No. 2 Tool & Cutter Grinder

DC Power Feed Motor — Diagnosis, Rewiring, and Final Configuration

Machine: Cincinnati No. 2 Tool & Cutter Grinder

Approx. Year: 1952

Subsystem: Table Power Feed

Motor: General Electric DC Motor, Type 5BC44AB2139

Prepared by: Restoration notes compiled during troubleshooting and repair

Purpose: Formal restoration record and technical reference

1. Scope and Intent

This document serves as a **formal restoration note** for the DC power feed system of a Cincinnati No. 2 Tool & Cutter Grinder.

It records the *actual as-found condition*, the investigative process, electrical measurements, internal motor topology, corrective actions taken, and the final verified wiring configuration.

The intent is to:

- Preserve technical knowledge that is not present in factory documentation
- Prevent re-introduction of known faults
- Aid future owners, restorers, and technicians
- Provide a factual record of deviations between schematic expectation and physical reality

2. Factory Design Intent (Summary)

The Cincinnati factory wiring diagram indicates the machine is designed to drive a:

Separately excited shunt DC motor

Key characteristics:

- Armature (A1/A2): variable, reversible DC
- Field (F1/F2): fixed DC, constant polarity
- Speed control via Powerstat varying armature voltage
- Direction reversal accomplished by reversing armature polarity only

This architecture is electrically sound **only** for a true shunt motor.

3. As-Found Symptoms

Prior to intervention, the following symptoms were observed:

- Feed motor operated in only one direction
- Severe speed difference forward vs reverse
- Speed control behaved non-linearly and inconsistently
- Selenium rectifiers ran excessively hot
- Transformer input fuses (2 A time-delay) blew under some conditions
- Motor wiring did not correlate cleanly with schematic expectations
- Motor presented five external leads, not four

4. Motor Identification

Nameplate Data:

- Manufacturer: General Electric
- Type: 5BC44AB2139
- Rating: 1/6 HP
- Voltage: 115 V DC
- Current: 1.8 A
- Speed: 1140 RPM

- Duty: Continuous
- Winding: **Compound**

The compound winding classification proved critical.

5. Motor Internal Construction (As Discovered)

Upon careful disassembly:

5.1 Mechanical Layout

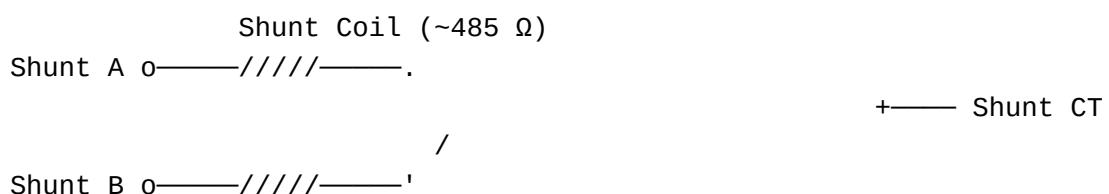
- Two carbon brushes, 180° apart
- Three field coils mounted to the housing:
 - Two large coils at 0° and 180°
 - One smaller coil at 90°

5.2 Electrical Topology

- The 90° coil is a **series field**
- The 0° and 180° coils form the **shunt field**
- One brush was originally routed through the series field
- Extensive cloth insulation concealed internal connections

6. Shunt Field Topology (Critical Discovery)

Resistance mapping revealed the shunt field is wired as follows:



- Shunt A and Shunt B are tied together with a very low resistance strap (~0.78 Ω)
- The true shunt field resistance (~485 Ω) exists between the A/B node and the center tap

- This configuration is typical of GE compound motors of this era but is **not obvious externally**

7. Resistance Mapping Results

| Measurement | Typical Value |
|-------------------------------------|-------------------------------|
| Brush \leftrightarrow Brush | $\sim 14.4 \Omega$ |
| Series A \leftrightarrow Series B | $\sim 1.86 \Omega$ |
| Shunt A \leftrightarrow Shunt B | $\sim 0.78 \Omega$ |
| Shunt A \leftrightarrow Shunt CT | $\sim 485\text{--}495 \Omega$ |
| Shunt B \leftrightarrow Shunt CT | $\sim 484\text{--}488 \Omega$ |
| Any lead \leftrightarrow frame | OL |

These measurements conclusively identified each winding.

8. Root Cause of Failure

The machine reverses **only the armature**, while the motor was compound wound with the series field in series with the armature.

This resulted in:

- Additive field in one direction
- Subtractive field in the opposite direction
- Torque and speed asymmetry
- Excess current draw
- Rectifier overheating
- Fuse failures (made obvious after selenium rectifier replacement)

9. Corrective Strategy

Several solutions were evaluated:

- Modify machine controls
- Replace motor
- Install modern DC drive
- **Internally convert motor to pure shunt operation**

The chosen solution preserved:

- Mechanical fit
- Original motor iron
- Machine control philosophy

10. Internal Motor Rewiring

Actions taken:

- Series field disconnected from armature circuit
- Both brushes brought out as independent armature leads
- Series field leads insulated and parked
- Shunt field left electrically intact
- Shunt center tap preserved

No windings were removed or altered.

11. Rectifier Modernization

Original selenium rectifiers were replaced with:

- **KBPC5010 silicon bridge rectifiers**

Result:

- Lower voltage drop
- Improved reliability
- Latent wiring errors became immediately detectable

12. Final Verified Wiring (Authoritative)

Armature

- A1 → Brush A
- A2 → Brush B

Shunt Field (IMPORTANT)

- Tie Shunt A and Shunt B together
- F1 → Shunt A + B node
- F2 → Shunt Center Tap

Not Connected

- Series field leads
- Any unused taps

13. Final Results

- Smooth speed control via Powerstat
- Proper reversing
- Equal performance forward and reverse
- No rectifier overheating
- No fuse failures
- System behaves exactly as Cincinnati intended

14. Lessons Learned

1. Do not assume motor topology from external leads
2. Resistance mapping is definitive
3. Compound motors hide non-obvious connections
4. Silicon rectifiers reveal faults masked by selenium
5. GE shunt fields often use outer-end strapping

Appendix A — Resistance Mapping Worksheet (Reference)

| From \ To | Brush A | Brush B | Series A | Series B | Shunt A | Shunt B | Shunt CT |
|-----------|---------|---------|----------|----------|---------|---------|----------|
| Brush A | — | | | | | | |
| Brush B | | — | | | | | |
| Series A | | | — | | | | |
| Series B | | | | — | | | |
| Shunt A | | | | | — | | |
| Shunt B | | | | | | — | |
| Shunt CT | | | | | | | — |

Appendix B — Safety and Verification Checklist

- All unused leads individually insulated
- No continuity from any lead to frame
- $\sim 485 \Omega$ measured across F1–F2
- $\sim 14 \Omega$ measured across A1–A2
- Field energized before armature
- Initial test at minimum Powerstat setting

Closing Note

This restoration resolved a subtle but fundamental mismatch between a compound DC motor and a shunt-motor control system.

The final configuration is electrically correct, mechanically original, and now fully documented.

Future guidance:

If symptoms reappear, repeat resistance mapping before replacing parts.

End of Restoration Note