Table of Contents

Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net

Preamble

This document is the authors best effort, it certainly is incomplete and probably has errors.

Document assumes:

- The horn is not working.
- It is a HO/FDG Bosch horn, the document may generally apply to the earlier HO/FAS Bosch horn; but author has not worked on one.

1 Revision History

	Published	Section	Change
Original	2021-10-08		Original publication

2 Giving Credit Where It Is Due

Thierry Van Nuffelen	Italian publication covering Bosch horn Low / Hi sound
Gordon Raymond / Terry Rushbrook	Alternative material for gasket fabrication
Multiple internet sources	Method of replacing original capacitor

3 Source of Information

Title	Pub.	Date	Coverage	Source
Giulietta Workshop Manual	637	1959/06	750	Author
Giulietta 1300 Spare Parts Catalog	776	1961/11	750 & 101-1300	Author
2000 Spare Parts Catalog (Table 78)	728	1960/11	Cast Iron 2000	Author
Bosch horn article	N/A	1960s	Bosch horn internals	Thierry Van Nuffelen
Horn catalog page	N/A	?	Bosch & Hella horns	Internet

Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net

4 How Does a Horn Work?

(750) Workshop Manual, publication 637, 1959/06

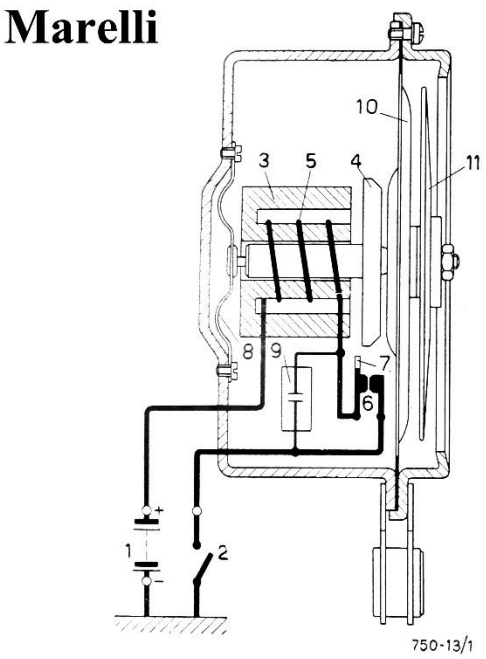
While this is written for the Marelli horn, the concepts also apply to Bosch.

The main components of the Marelli horn are:

- *The diaphragm which is caused to vibrate by the electromagnet and which emits the sound;*
- *The electromagnet designed to cause the diaphragm to vibrate.*

How it works:

- *The diagram in figure (at right) clearly demonstrates the operation of the horn; by closing the circuit in practice effected by pressing on the horn ring on the steering wheel) a magnetic field is created by means of the electromagnet which then attracts the armature 4 connected to the diaphragm 10.*
- *By moving towards the electromagnet, the armature operated circuit breaker 6 in such a way as to open the electric circuit; the magnetic effect then fails and the armature returns to the initial position.*
- *When the armature thus returns to its original position, the circuit breaker contacts close and restore current to the circuit. The cycle is then repeated.*
- *The very frequent repetition of the opening and closing of the electromagnet circuit cause the diaphragm to vibrate and the horn sounds. The tone of the horn depends on the frequency of the oscillations.*



The electric wiring diagram of the Marelli electric horn
1. Battery - 2. Push button - 3 Electromagnetic core - 4. Electromagnet armature - 5. Electromagnet coil - 6 Circuit breaker - 7. Contact spring - 8. Leaf spring - 9. Condenser - 110. Diaphragm - 11 Loud-speaker cone.

5 Horn Type

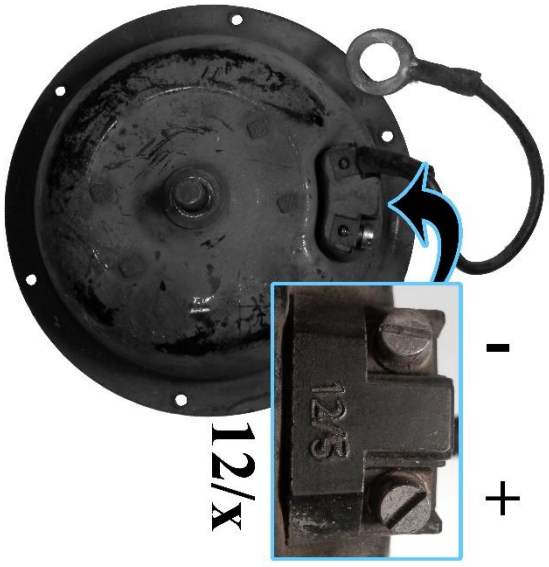
Bosch labels the 750-101 horns as “disk horns”’ whereas the term for the later 105 horn is “fanfare horn”.

6 Electric Connection

The (**750) Workshop Manual** illustration (above) indicates the +12 volts connected to the electromagnet Coil and the ground is connected to the Stationary-Point.

A few Bosch samples supported the concept (see photo).

The author is not convinced it matters, but uses that convention throughout this document.



Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net

7 Variations

Over the years there were some internal changes, the following have been observed:

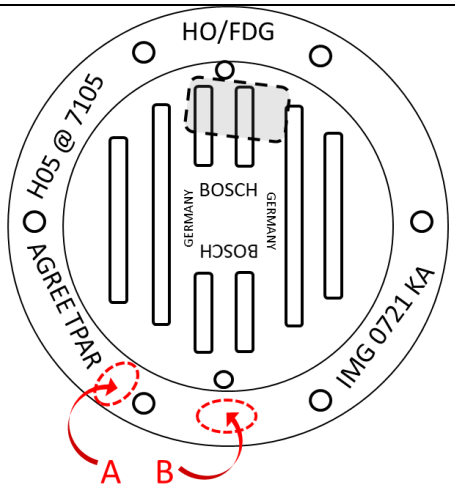
- **Screw thread / pitch of screw holding Moveable-Point and the ID of all associated washers and spacers. One version is an unusual 3.5 x 0.6 thread.**
- Size / shape of Bakelite harness connection module (32.6 mm and 38.6 mm wide)
- Gauge of wires connection to electromagnet coil
- Capacitor and capacitor clamp design (metal cap / single hole clamp or no cap / multi-prong clamp)

None of the above probably impacts how to repair the horn.

- The engraving on the front grill also changed, see below

7.1 Grill Mark Variations

The following have been observed:



Low / Hi Sound	Mark on Bakelite	Alfa #	Grill Mark "A"	Grill Mark "B"
Low	12/1	101.03.65.126.00	294 323 295 342	290
			295	….. nothing
Hi	12/5	101.03.65.127.00	296 298	362
			296	….. nothing

- It has not been determined what information the "A" mark is intended to provide.
- It appears that "B" mark, when present, refers to Tief (deep – 290 Hz) and Mittel (medium – 362 Hz).

Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net

8 Low / Hi Tone

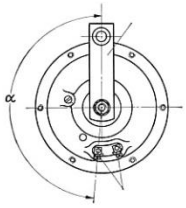
Bosch explanation for why two horns: "*A high-tone horn produces a more piercing sound. This enables the signal to reach forward and farther. The low-tone horn, with a lower frequency, is better heard at close range*." Alfa horns are probably what Bosch labels "125 mm". See chart below for a sample of frequencies Bosch provided different manufactures.

Tone	Alfa #	Bosch #	Bakelite Emboss	Bosch 10 Digit #	Bosch Description	English Translation
Low	101.03.65.126.00	HO/FDG 12/1		0 320 106 001	Tief (290 Hz)	Deep
Hi	101.03.65.127.00	HO/FDG 12/5		0 320 106 004	Mittel (362 Hz)	Medium

BOSCH-Tellerhörner

025

Elastische Aufhängung an drehbarer Federlasche gewährleistet volle Ausnützung der Schallenergie.
Alle BOSCH-Hörner gleicher Bauart, aber verschiedener Tonlage (tief, mittel), können als Zweiklanghörner verwendet werden.


Skizze für die Stellung der Blattfederhalter


Normaltonhorn 125 mm Ø Loch 10,5 mm


Kleines Tellerhorn 100 mm Ø Loch 8,5 mm


VOLKSWAGEN-Tellerhorn 0320 120 004


Starktonhorn Loch 10,5 mm

Bemerkungen; Verwendung z. B.	α	Schwingungen/sek	Tonlage	V	Best.-Nr.	Preis DM	Bisherige Bezeichnung	BOSCH-Nummer
Kleine Tellerhörner, 100 mm Ø, schwarz lackiert								
schwarz ... mit Bolzen	120°		mittel	6	**42/1**	13.—	HO/FCH 6/1	0 320 005 001
schwarz ... mit Bolzen	120°		mittel	12	**42/5**	13.—	HO/FCH 12/1	0 320 006 001
schwarz; Flachsteckeranschluß	120°		mittel	12	**42/6**	13.—	HO/FCH 12/9	0 320 006 009
Normale Tellerhörner, 125 mm Ø, schwarz lackiert								
Bolzenanschluß:								
allgemein	175°	290	tief	6	**42/10**	16.30	HO/FDG 6/1	0 320 105 001
allgemein	175°	362	mittel	6	**42/11**	16.30	HO/FDG 6/5	0 320 105 005
Opel, Befestigungsloch für M 8	220°	260	tief	6	**42/12**	16.30	HO/FD 1/6/3	0 320 110 003
allgemein	175°	290	tief	12	**42/20**	16.30	HO/FDG 12/1	0 320 106 001
allgemein	175°	362	mittel	12	**42/21**	16.30	HO/FDG 12/5	0 320 106 004
Flachsteckeranschluß:								
Opel	45°	260	tief	6	**42/30**	16.30	HO/FD 1/6/5	0 320 110 005
Opel	315°	325	mittel	6	**42/31**	16.30	HO/FD 1/6/6	0 320 110 006
Volkswagen	265°	290	tief	6	**42/32**	16.60	HO/FD 1/6/9	0 320 110 009
Volkswagen	133°	290	tief	6	**42/33**	16.60	HO/FD 1/6/10	0 320 110 010
Auto-Union	192°	290	tief	6	**42/34**	16.30	—	0 320 110 011
Volkswagen 1200 und 1500	90°	335	mittel	6	**42/35**	16.60	—	0 320 120 004
NSU	348°	260	tief	12	**42/40**	16.30	—	0 320 113 006
BMW	313°	290	tief	12	**42/41**	16.30	HO/FDG 12/24	0 320 106 016
Opel	45°	260	tief	12	**42/42**	16.30	—	0 320 113 004
Opel	315°	325	mittel	12	**42/43**	16.30	—	0 320 113 005

Starkton-Hörner, Ein- oder Zweiklangsignal zum sicheren Überholen; mit gerichteter Schallenergie

BOSCH-Nummer	Bisherige Bezeichnung	Best.-Nr.	Preis DM	V	Tonlage	Schwingungen/sek	α	Bemerkungen
0 320 201 010	HO/FSA 6/9	**42/50**	27.—	6	tief	290	165°	schwarz
0 320 201 005	HO/FSA 6/10	**42/51**	27.—	6	mittel	345	165°	schwarz
0 320 202 016	HO/FSA 12/9	**42/55**	27.—	12	tief	290	165°	schwarz
0 320 202 006	HO/FSA 12/10	**42/56**	27.—	12	mittel	345	165°	schwarz
0 320 203 012	HO/FSA 24/9	**42/60**	35.—	24	tief	290	165°	schwarz
0 320 203 013	HO/FSA 24/10	**42/61**	35.—	24	mittel	345	165°	schwarz
0 320 201 003	HO/FSA 6/6	**42/70**	34.—	6	tief	290	165°	Deckel verchromt, Gehäuse schwarz
0 320 201 004	HO/FSA 6/7	**42/71**	34.—	6	mittel	345	165°	Deckel verchromt, Gehäuse schwarz
0 320 202 004	HO/FSA 12/6	**42/75**	34.—	12	tief	290	165°	Deckel verchromt, Gehäuse schwarz
0 320 202 005	HO/FSA 12/7	**42/76**	34.—	12	mittel	345	165°	Deckel verchromt, Gehäuse schwarz

BOSCH-Blattfederhalter
(Federpakete)

für Hörner HO/FDG
HOBE 4 G 1 Z/1321 234 050
Nr. **42/90** ..... DM 1.80

für Hörner HO/FSA
HOBE 4 G 3 Z/1321 234 052
Nr. **42/91** ..... DM 1.80

8.1 What Causes Low / Hi Tone

Evidence points to the shape and thickness of the Diaphragm/Armature Plate is the controlling factor in whether the horn is "Low" or "Hi". A thicker Diaphragm/Armature produces a higher frequency sound.

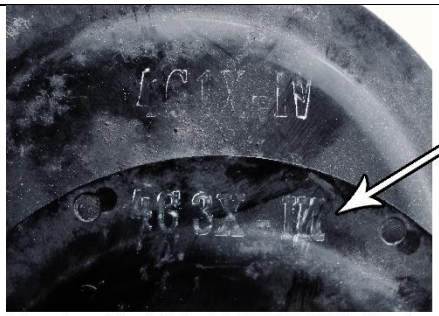
- The (Cast Iron) 2000 Spare Parts Catalog provides more indicators for the predecessor horn to HO/FDG:

(Cast Iron) 2000 Spare Parts Catalog			Old Bosch Catalog	
1365.76.448	HO/FSA	12/9	12/9	"Tief" (deep)
1365.76.449	HO/FSA	12/10	12/10	"Mittel" (medium)

- A 1960s Italian article on Bosch horns provided the following:
  - *The steel membranes have a variable thickness between 0.4 and 0.7 mm (in general 0.5 mm) in function of the desired tone. At equal dimensions and shape, a thicker membrane results in higher frequency.*
  - *A 100 mm x 0.5 mm membrane has a frequency of 290~340 Hz, a 100 mm x 0.7 mm membrane has a frequency of 380~420 Hz.*

During the development of this document the following was observed:

One pair of horns had diaphragm/armature plates with silk screened / white paint markings



The other side of disk with "4G3X-IV" in felt tip pen marking was ""413". Maybe indicating the Hz.

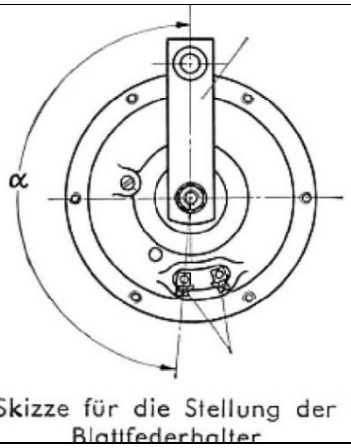
(After paint removed):				
Low/Hi	**Bakelite Mark**	**Thickness Diaphragm/Armature**	**Height Diaphragm / Armature**	
Low	12/1	.511	.60	
		.503	.62	
		.522	.68	
		.512	.54	
		.505	.68	
Hi	12/5	.603	1.50	
		.630	.91	
		.614	1.65	

8.2 Mounting Bracket

The Bosch catalog page shown in **Low/Hi Tone** section contains an illustration showing the position (ά) of the mounting bracket relative to the electrical connection terminals.

The catalog then lists a different position (ά) for each vehicle / horn combination; therefore, do not just match the illustration during reassembly. A photo of an unmolested Alfa horn is included in **Reassembly Part 3 & Adjustment** section.

Translation of word on illustration:
"Sketch for the position of the leaf spring holder"



9 Tools & Supplies

9.1 Tools

The following tools were used for the described repairs:

- Multimeter – having a capacitance setting is a plus.
- Screw drivers
- Scissors
- $^{1}/_{8}$" hole punch
- Relatively soft brass brush (consider one sold for brushing suede leather shoes)
- A very helpful item is a hobbyist vice, for example PanaVice. This is particularly helpful for holding the points as they are polished

9.2 Supplies

- 4 mm stainless steel lock washers (originals were chrome plated)
  HINT: always use new lock washers and use ones that will not rush.
- Electrical contact cleaner
- 2000, 1000, and 800 grit sandpaper (any automotive supply store), used with a piece of smooth steel approximately ½" wide and $^{1}/_{10}$" thick
- $^{1}/_{64}$" paper gasket material (Fel-Pro #3022, 36" x 18" x 1/64")
  This is the thinnest generally available, but is still twice as thick as originals.
- Bee's wax to seal adjustment screw.

Depending on required repairs:

Coil broken wire repair	22-gauge solid copper "hook up wire" (Radio Shack or similar)
Grommet replacement for Bakelite harness connector	Options: • 3M strip chalk • Stepped grommet (hardware store)
Bakelite broken	• JB Weld Plastic Bonder (2-part epoxy for plastic) • Dupli-Color PAE101 Semi-glass black acrylic enamel

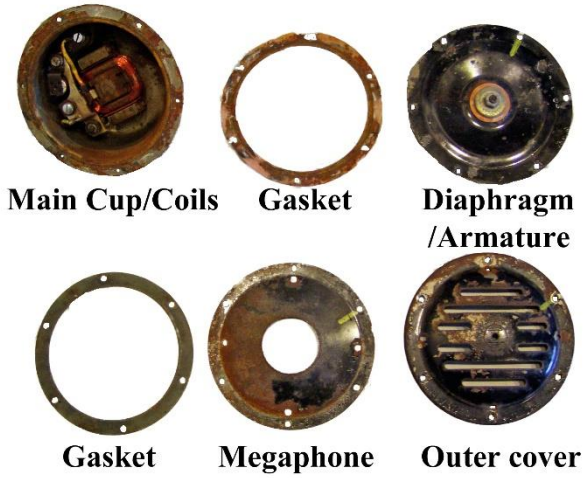
9.3 Capacitor Replacement Supplies

The following were used for this document:

0.22 microfarad "film" capacitor	eBay - January 2021, 12 Panasonic brand for $10.07
Nylon spacer ½" x 1" for #10 screw	Hardware store – less than $1
(2) Copper $^{3}/_{16}$" x .375" rivets	McMaster-Car 97440A355 – January 2021, 50 for $10.78 + shipping

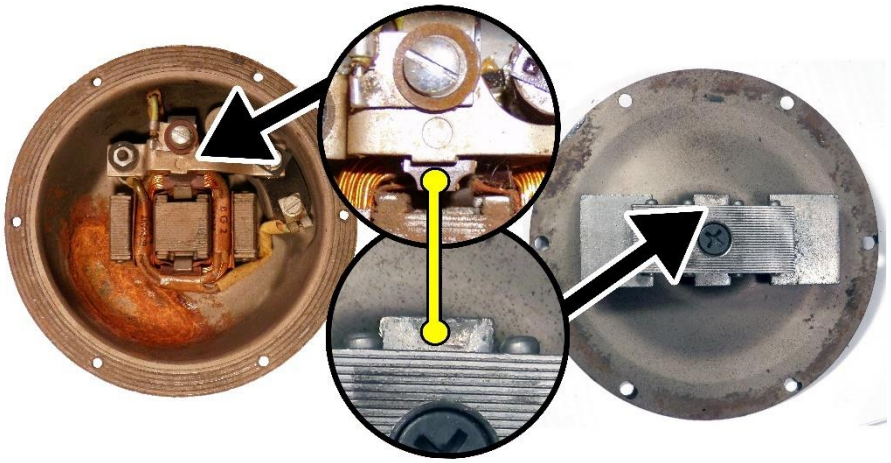
10 Disassembly – Part 1

- While probably only the "Diaphragm/armature plate" has a specific orientation; play it safe and mark each layer's original position during disassembly.
- The inner holes in "megaphone" line up with inner holes in "Outer cover"
- Remove six screws on the rim of the horn.
- Carefully separate the layers, so that the two thin (0.2 mm) paper or plastic gaskets are preserved. Some horns have multiple gaskets between Main Cup/Coils and Diaphragm/Armature.

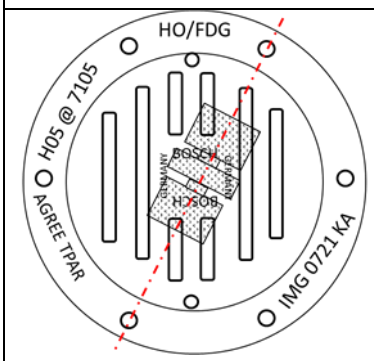


Now look at the side of the diaphragm/armature plate that faces the electromagnet. Observe the protrusion on the armature (metal bar attached to the diaphragm/armature plate) on the side that faces the points and capacitor.

You will probably see a slightly worn or shiny spot. This is where the bar hits the Moveable-Point to break the electrical connection which makes the horn work.

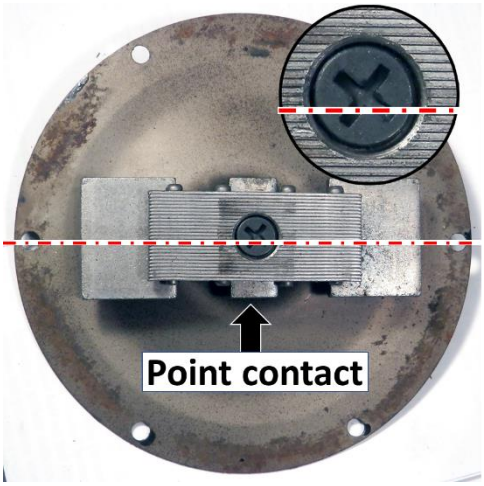


Hint: clearly mark the contact side with paint



It appears that some armatures are slightly offset on the diaphragm plate for the point contact. Record what you find:

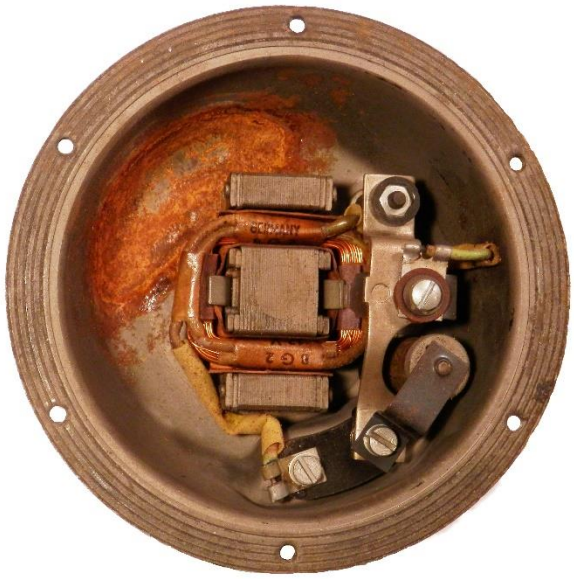
□ Offset
□ Not offset



Disassembly

Although there are gaskets, the seal is imperfect. Therefore, dirt and water will eventually reach the critical interior.

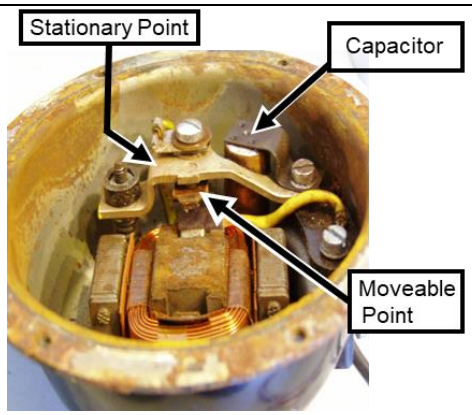
It appears Bosch anodized the interior of the main shell and the armature side of the diaphragm plate, but that was not enough to prevent rust after water entered. As rust forms, the vibrations turn the rust to a talcum powder consistency that floats onto the electromagnet's points. The powder then burns onto the points; eventually causing them to fail.



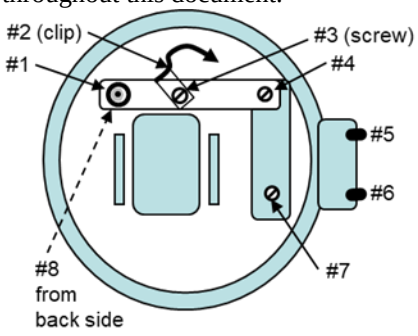
CAUTION: During the next step take care not to break the wire between capacitor and electromagnet as you complete the disassembly.

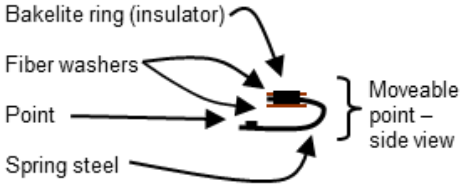
Study the diagrams so you know what to watch for as you continue the disassembly.

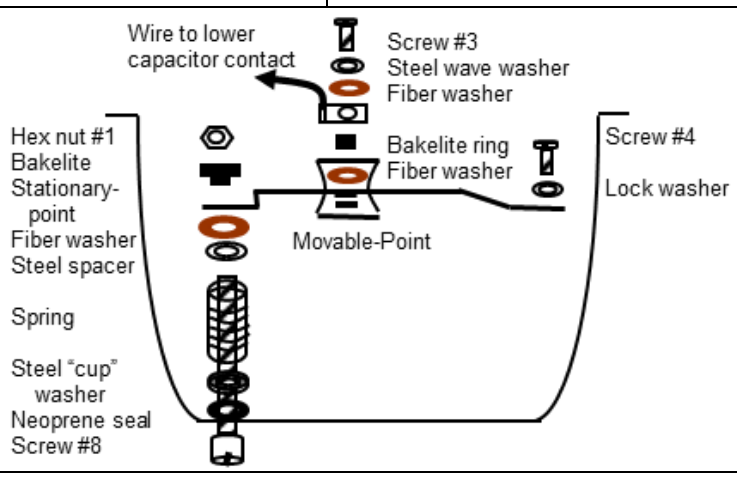
- Remove only the screw labeled #3 and the other pieces associated with the Movable-Point (see below).
- **CAUTION**: on some horns this is an odd 3.5 x 0.6 screw; while on some horns it is a common 4 x 0.7.



These numbers will be referred to throughout this document.

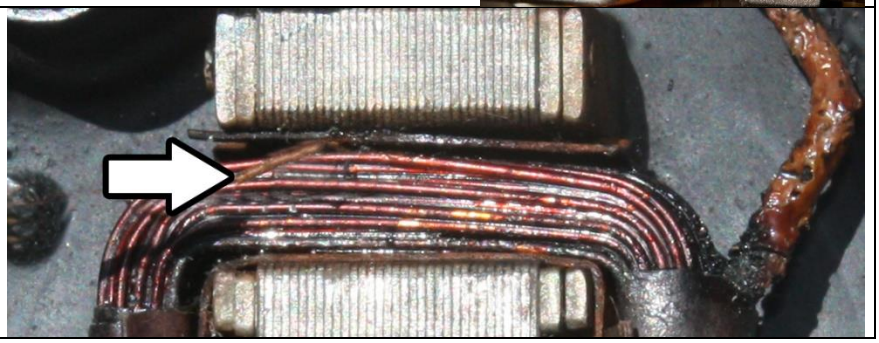






11 Evaluation

11.1 Visual

Examine Bakelite harness connector for cracks or missing pieces.	What you hopefully will not find: 
Look for arcing at all electrical connections. It can be caused by: • Deteriorated insulators • Corrosion	This wire is covered with carbon deposits from arching. 
Look for broken wires. (example in photo, this wire should have connected with capacitor holder.)	

11.2 Screws

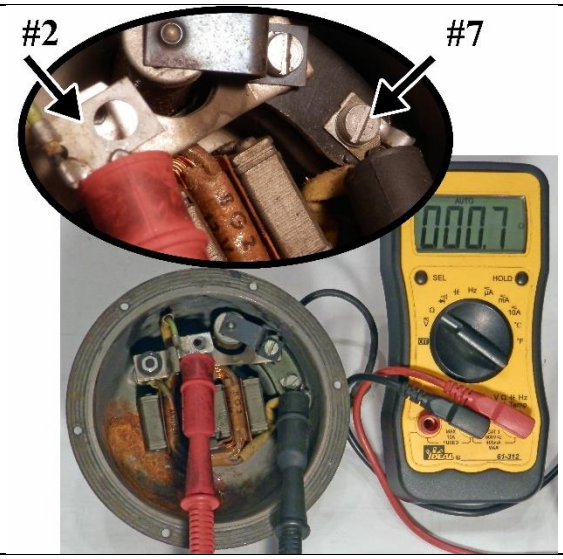
As you proceed through the disassembly steps, verify all screw threads and the threaded holes are in good condition. Replace / refurbish as necessary.

Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net

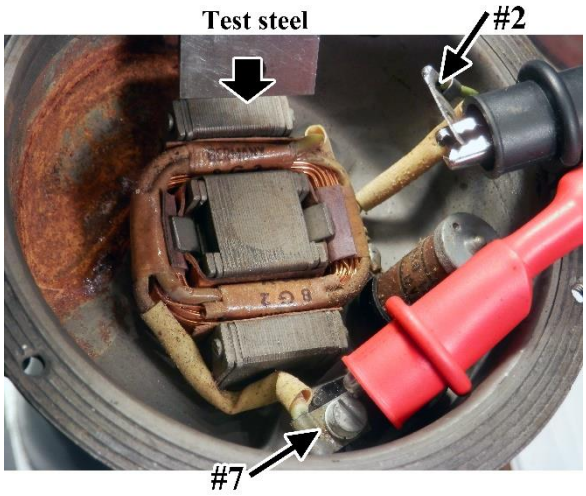
11.3 Electromagnet Coil – Tests

11.3.1 Electromagnet – Resistance Test

Based on eight horns, the expected value is 0.8-0.9 ohms.

Connect ohm meter leads to: • Clip #2 • Screw #7 If your meter has residual internal resistance, remember to subtract the value to obtain actual reading. If the resistance is high, clean all connections and repeat test. If the resistance is "infinite" (open circuit), investigate if either wire entering coil is broken (Footnote [1]). If that is not the case, the coil is probably burned out and a new horn will have to be found.	

11.3.2 Electromagnet – Strength Test

CAUTION: do this just briefly so the coils do not overheat. • Using a 12-volt power source: • Connect negative lead to Clip #2 • While holding a piece of steel above the electromagnet coils, briefly tough positive lead to Screw #7 • The steel should be **strongly** attracted to the electromagnet. • If the steel is only weakly attracted, try cleaning the connections. • If still weak, move on to capacitor tests. **CAUTION**: keep your fingers out of the way … this will hit like a hammer if it is functioning properly.	

[1] Of the nine horns I took apart, one had a broken wire.

11.4 Capacitor (Condenser)

CAUTION: don't remove the capacitor unless you have to in order to avoid damaging bottom connector.

The purpose of the capacitor (or condenser if you prefer) is to keep the points from arching, which causes them to burn. Capacitors are measured in farads.

Name	Symbol	Conversion	
picofarad	pF	1 pF = 0.001 nF	
nanofarad	nF	1 nF = 0.001 µF	1 nF = 1000 pF
microfarad	µF	1 µF = 0.001 mF	1 µF = 1000 nF
millifarad	mF	1 mF = 0.001 F	1 mF = 1000 µF
farad	F		1 F = 999.5 mF

- Internet sites indicate 0.22 µF (220 nF) is the expected value.
- I have found ratings between 199 nF and 236 nF.

11.4.1 Variations

- Two versions of this paper & foil tubular capacitor have been observed.
- There are matching retainer variations
- The version without a cap is probably the older version

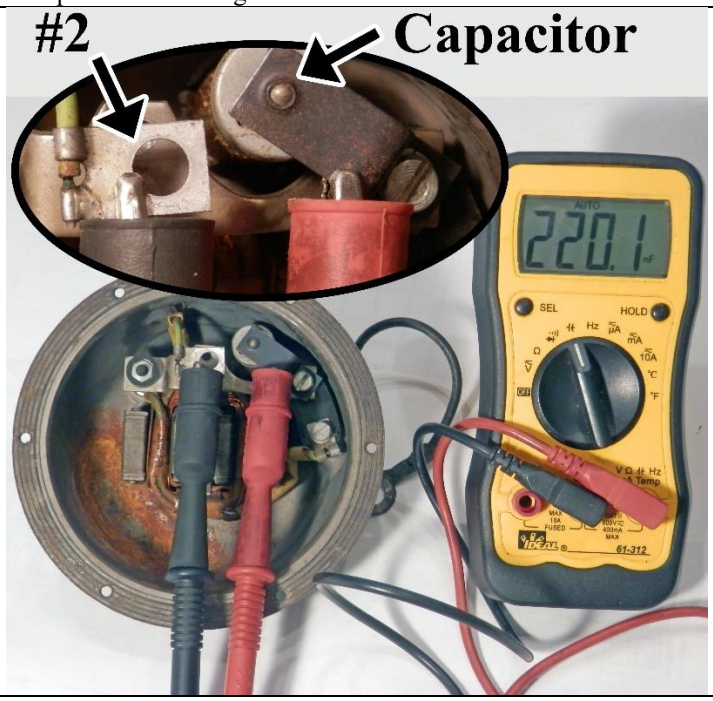
11.4.2 Capacitor Rating - Test

This operation requires a multimeter with "Capacitance" setting.

Note: you must hold meter contacts to the capacitor until the meter stops changing its reading. It takes a while for the capacitor to be fully charged.

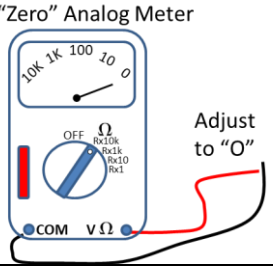
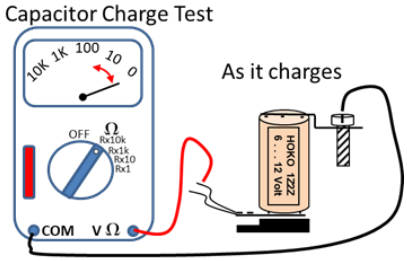
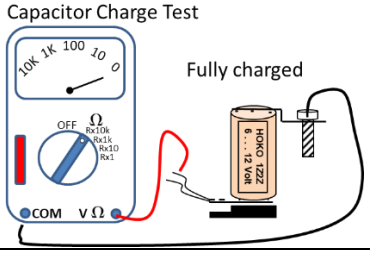
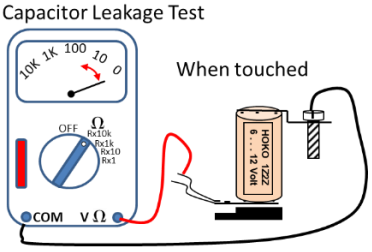
- Black lead to wire Clip #2
- Red lead to top of capacitor

If not close to this rating, replace the capacitor.



11.4.3 Leaking Capacitor – Test

A conventional analog (not digital) meter is best to make this test. Depending on the display speed of your digital meter, it may be an adequate substitute.

	Meter Connection	Spec.	Expectation
First, "zero" your meter "Zero" Analog Meter 	• Set meter to highest ohm range (for example "Rx10k"). • Red lead connected to "V/Ω" on meter • Black lead connected to "COM". • Connect Red to Black	0	Adjust to 0
Capacitor Charge Test  Capacitor Charge Test 	Charging capacitor: • Black lead to top of capacitor • Red lead to Clip #2 • Hold for 20 seconds • Disconnect Black lead only **WARNING**: Do not touch capacitor with hand between steps.	Meter action: • Starts at ∞ • Briefly jumps toward zero • Then fall back to ∞	If this pattern of movement is not observed, the capacitor must be replaced.
WAIT 2 minutes			
Capacitor Leakage Test 	Checking if capacitor has leaked: • Return Black lead to top of capacitor	Meter should not move.	If meter moves, it has leaked. • If movement is slight it may still be useable • If as much as 1st time, replace it.

Replacement of the capacitor will be covered in the **Repair** section.

11.5 Decision

- Of nine horns disassembled, all but one had a capacitor within specification, but not one of them would hold a charge for one minute.
- If the electromagnet coil is weak, with a good capacitor and all connections clean; look for another horn.

Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net

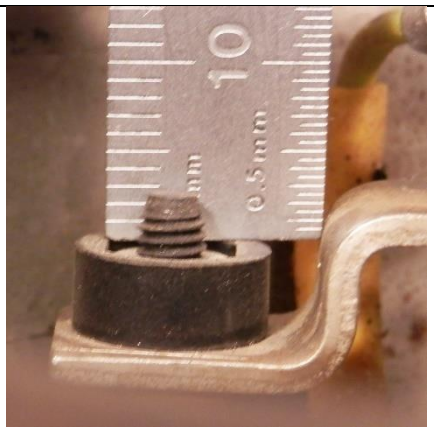
12 Disassembly – Part 2

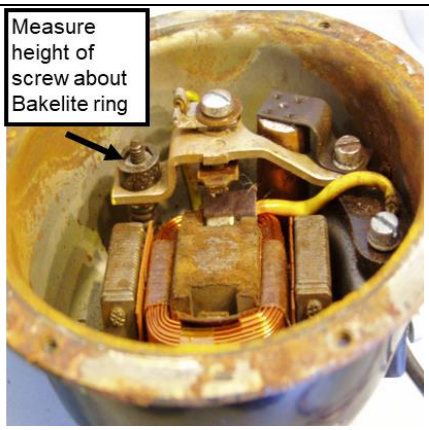
Note: this is the "Adjustment Screw" that is used to set armature to Moveable-Point clearance.

- Measure the distance the screw protrudes above the Bakelite. The values I have found are typically around 3 mm. This one was 2.5 mm.
- Take a picture, that way you can also count exposed threads.

RECORD VALUE:

- Height _____
- Tread count _____





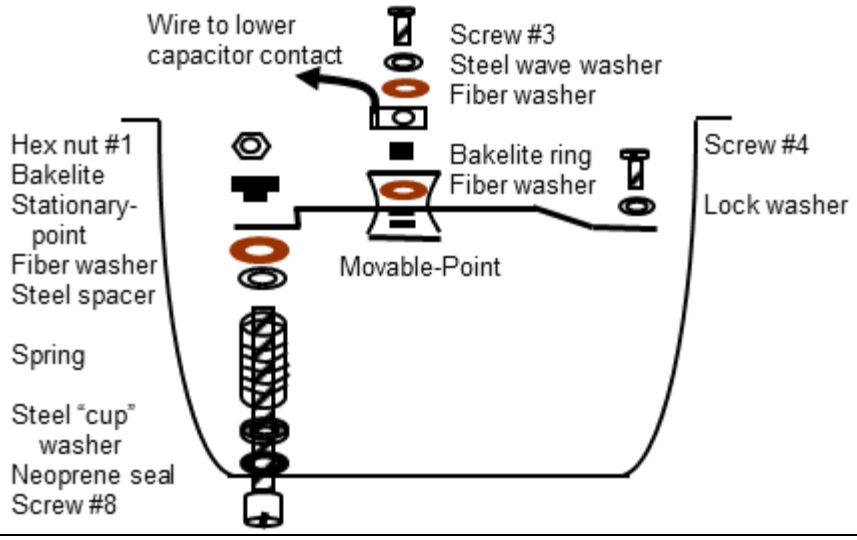
Note this screw comes in from the back of the horn Main Cup.

Note: the screw head should be covered with a wax seal. Take a picture of the seal, so you can duplicate for you concourse winning projects.

If the seal is missing it is likely the horn has already been repaired at least once.

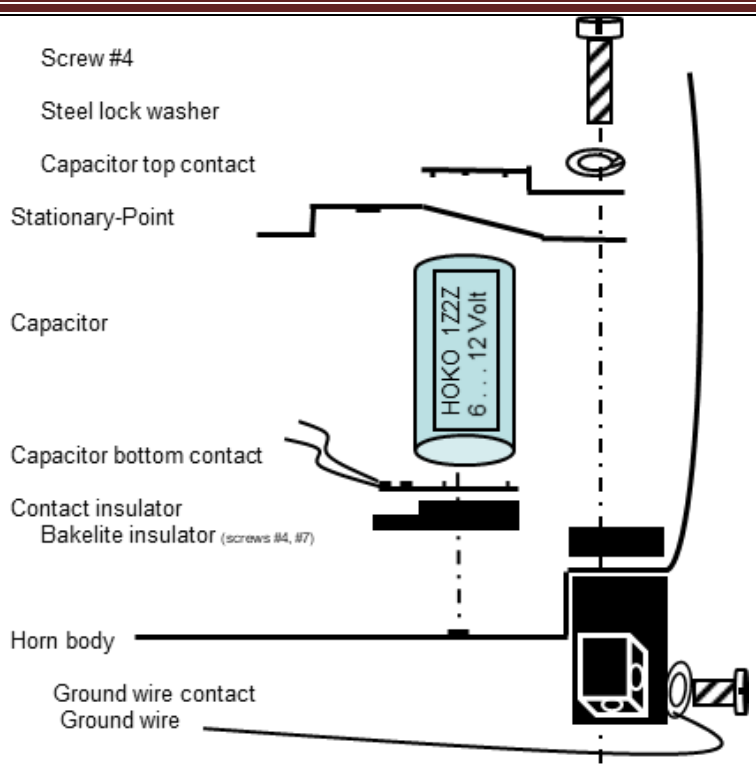
Study the diagrams so you know what to watch for as you continue the disassembly.

- Turn Screw #8 to remove Nut #1 & Bakelite Nut Holder



Disassembly – Part 2

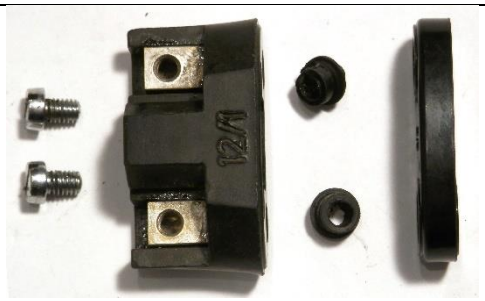
- Remove Screw #4
- Remove capacitor top contact
- Remove Stationary-Point holder
- Remove all components associated with Screw #8



This step is not required to repair the horn, only to provide access for fully painting the Main Cup.

- Remove Screw #7
  CAUTION: don't let exterior piece fall and break
- Carefully pry up the interior Bakelite piece.

CAUTION: 2 special rubber grommets are under Bakelite



Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net

13 Rust Removal / Painting

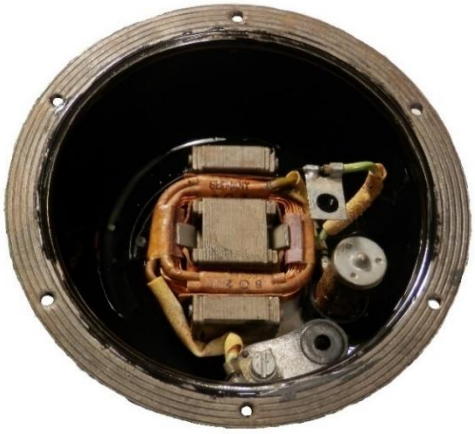
13.1 Color

After disassembly of a Diaphragm/Armature Plate, it revealed a part of the plate that was never exposed before; it appears that the paint originally was a high gloss black.

13.2 Interior

- Now that everything you can remove is out of the way, clean the rust out of the inside of the housing as best you can. Use a scraper, sandpaper, or whatever you are comfortable with. Be careful not to damage the electromagnet coil or its connecting wires as you clean. You are not going to be able to get it all, but do what you can.
- Spray a heavy dose of electrical contact or electrical motor cleaner over the entire interior. Tip over the housing to drain off the excess cleaner. Then let it air dry.
- Clean with isopropyl alcohol
- Clean with well water or distilled water (not city treated water)
- Dry with hair dryer
- Note: because the wires can't be fully protected, I did not use the usual acid wash before painting.

Paint the interior without getting it on the wires.
Consider POR 15 for its ability to stabilize rust.

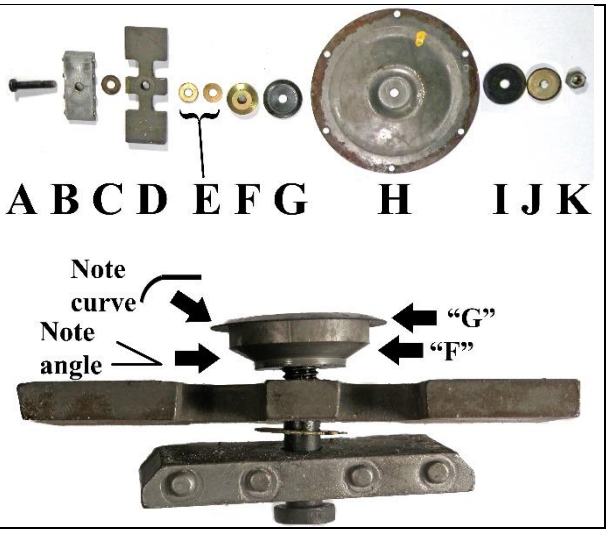


13.3 The Rest

Disassembly of the Diaphragm/Armature Plate was not done in previous steps. You may wish to do this for a more complete paint job, but damaging the molded paper (or plastic) disks (G & I) may provide enough reason to leave it alone.

CAUTION:
- Horns have varying thickness shims at C & E
- Horns have varying numbers for shims at point "E"

RECORD VALUES:
C: _____
E: _____
See **Hardware List** section for detailed measurements.



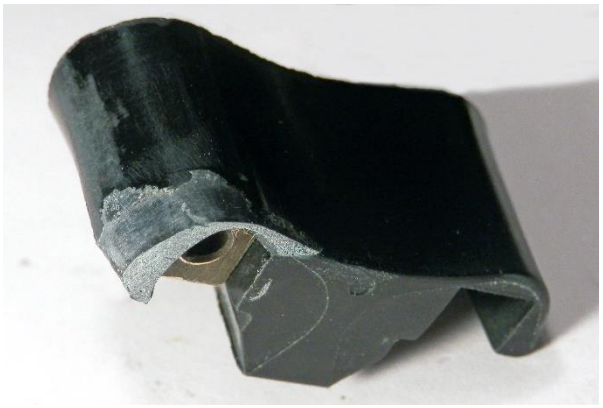
If you decide to paint all the horn components
- Use only a thin layer of paint on the Diaphragm/Armature Plate. Heavy paint will interfere with the flexing which is what makes the sound.
- While the paint is drying, you can do the next steps.

14 Repair

14.1 Bakelite

This type of damage can be repaired with JB Weld Plastic Bonder 2-part epoxy and then painted. A "mold" was created by simply wrapping cellophane tape around the part.

After curing it is a good match to the black color, but it turns to gray if sanded.



Painted "semi-gloss" black

14.2 Gaskets

Make two new gaskets from paper gasket material or plastic. (Another horn restorer has suggested yellow envelop paper soaked in "sealing wax used for home canning".)

- While it is twice as thick as the original material, I was able to use readily available 1/64" (0.4 mm) gasket paper.
- Scissors work well to cut these gaskets.
- An $^{1}/_{8}$" hole punch works well for punching out the screw holes (cheap Harbor Freight is useable).

Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net

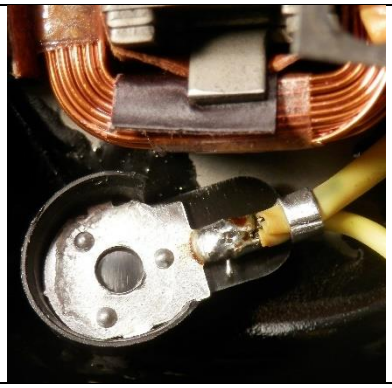
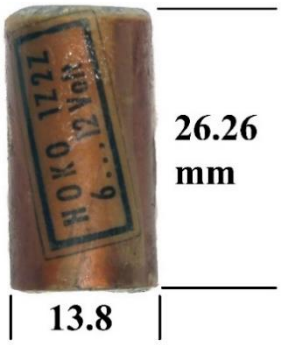
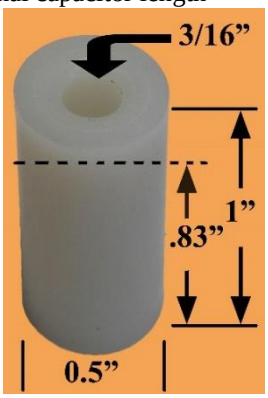
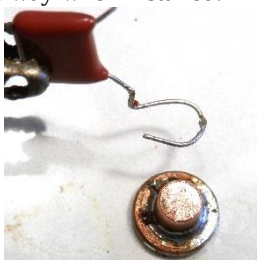
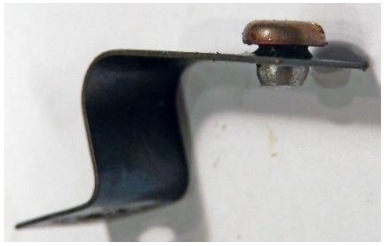
14.3 Polishing the Points

Note: if you have an old "point file" in you tool box, leave it there; because it will destroy the points.

- A hobbyist vise, for example PanaVice, is a great way to hold the point while polishing it.
- Spray the points with electrical contact cleaner and then use a relatively soft brass brus to take off dirt and light glaze.
- Wrap a strip of 1000-grit sandpaper around a metal strip (approximately ½" wide by 1/10" thick).
- Rub primarily in circular motions. Be careful to retain the flat surfaces of the points.
- After a little polishing, check the results. If you can see definite burned spots that are not going to be removed with 1000-grit, use the 800-grit paper. Work with the 800-grit until you can get rid of the most of the burn spot.
- As you polish, watch that you retain an even shiny circle on the point; which tells you it will be flat and level. This example (right) is starting to have too much cut on one side.
- You may not be able to get rid of 100% of the burn spots and still have sufficient point surface left.
- Return to the 1000-git to remove sanding scratches you just inflicted on the point.
- Finally polish to a flat, mirror-like surface with the 2000-grit. Remember; take off no more than you absolutely have to.
- Again, clean with electrical contact cleaner

As found	After electrical contract cleaner and soft brash brush	After polish (small scratches, but also hand of photographer).
Stationary-Point		
		, but also hand of photographer) 
Movable-Point		
		
Mistakes		
Here is what happened if you get in a hurry and use too aggressive paper	Mistake of using 320-grit 	Stopping too soon, still some scratches and pits 

14.4 Capacitor Replacement

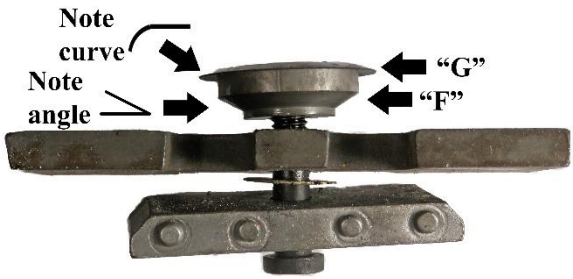
CAUTION: use screwdriver to hold the bottom connector from moving, while wiggling the capacitor free.		
	Common hardware store nylon spacer. Shortened to recreate original capacitor length 	Add solder to end of copper rivet to provide softer electrical contact.  **CAUTION**: verify two rivets do not touch when inserted into the plastic tube.
Bend 0.22 microfarad capacitor leads to keep capacitor close to nylon support. Make 1st lead close to one end of nylon support, so capacitor is out of the way when installed. 	Solder the capacitor to both rivets. 	If the capacitor hold-down clamp is of the “single hole type”, solder a 3 mm brass screw into the hole in the clamp to improve the connection. 

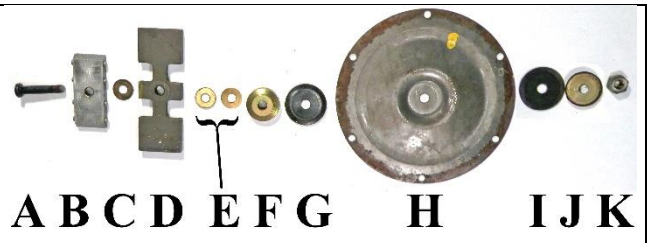
If you paint is now dry, move on to the next step.

15 Reassembly – Part 1

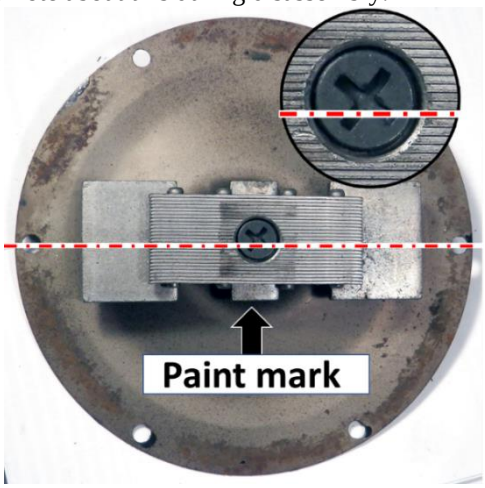
If Diaphragm plate was disassembled:

- Reassemble according to your recorded values for the "C" and "E" spacers.
- Pay attention to orientation of components:





REMINDER: at least some armatures are slightly offset on the diaphragm plate for the point contact. You were to make a note about this during disassembly.

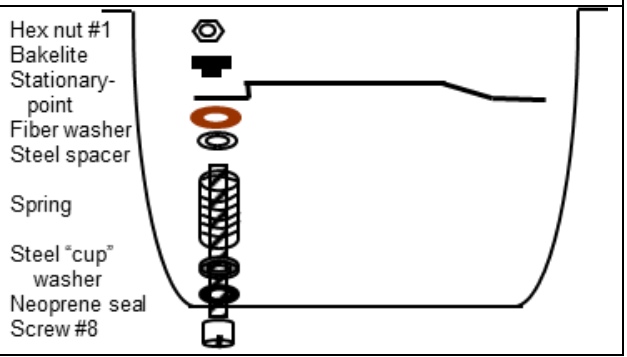


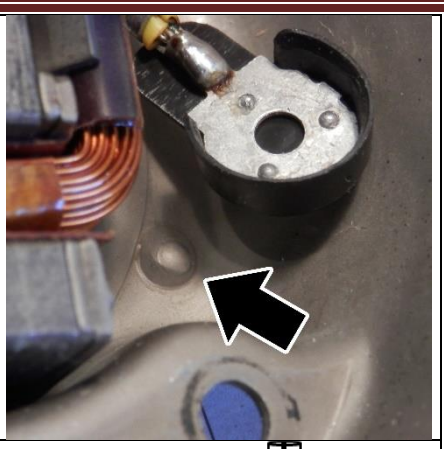
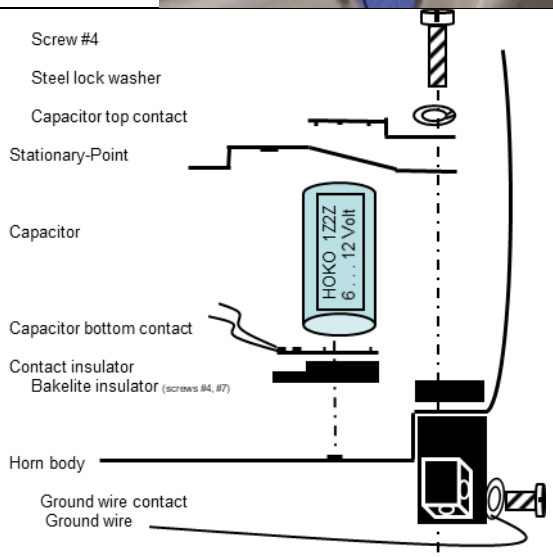
If Bakelite Harness Connector was removed:

- Install good grommets (or 3M strip chalk) into holes in Main Cup.
- Insert Screw #7 (18 mm long) through **new** stainless steel lock washer, coil wire hoop connector, and interior Bakelite piece; and then screw into grommet until it just protrudes slightly outside.
- Hold outer Bakelite piece in place and then loosely tighten Screw #7.

HINT: if the neoprene seal is not in near perfect condition, replace it.

Loosely install Screw # 8 with all its washers, spring, Stationary-Point Holder, Bakelite cup, and nut.
CAUTION: be sure Bakelite cup is fully seated into the Stationary-Point Holder slot.



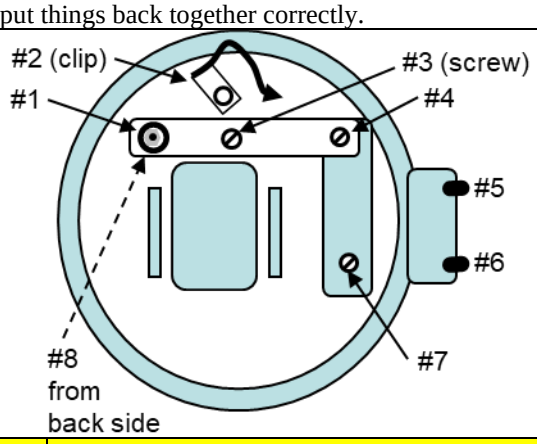
If Capacitor was removed: If reusing the original capacitor: • Install it in the same direction it came out. • If metal-cap type, cap is on top • If no-cap type, 4 indentations is on top (3 indentation on bottom) Otherwise, install new film-capacitor unit	Note: there is a bump in the shell (arrow in photo) for positioning the bottom of capacitor 
Install the Capacitor Clamp • Insert Screw # 4 (20 mm long) through **new** stainless steel lock washer, Capacitor Clamp, Stationary-Point Holder, and interior Bakelite piece. • Hold outer Bakelite piece in place and loosely tighten Screw # 4. **CAUTION**: there is a "bump" in the shell for positioning the bottom of Capacitor • Fully tighten Screw #4, while holding Capacitor in place **CAUTION**: Be sure the top of the capacitor or its wires do not touch the Stationary-Point holder or main horn case. **CAUTION**: Verify the coil wire under Screw #7 is not touching any metal parts. • Fully tighten Screw #7 • Verify capacitance (see below) meets specification by connecting meter leads to Screw #4 and the wire to the lower capacitor contact.	
Install Screw 5 and Screw 6 with **new** stainless steel lock washers.	

15.1.1 Capacitance Test

Meter with capacitance setting:	Verify value matches specification (0.22 µF or 220 nF)
"Analog" ohm meter:	1st rising resistance for 2 seconds as capacitor loads; then "Infinite".

15.2 Continuity Testing – with Capacitor Disconnected

While your problem was probably burned points, let not assume it is the only problem. Hopefully, you will be lucky. These steps will also verify you put things back together correctly.



Meter Lead 1	Meter Lead 2	Expected Results	Possible Problem
• The following tests are completed with the **points OPEN**. Since the Movable-Point has yet to be installed, this is true. • To use these tests after the Movable-Point has been installed, separate the points with a piece of plastic. • Included are typical readings I have found. As necessary adjust your readings to compensate for the inherent internal resistance of your meter. They have been adjusted for author's Fluke 78.			
#2 (Clip)	#1	"Infinite"	"A"
	Hole for #3	"Infinite"	"B"
	#4	As above	
	#5	As above	
	#6	0.9 ohms	"B"
	#7	0.9 ohms	"B"
Hole for #3	#1	"Infinite"	"A"
	#4	0.1 ohms	"C"
	#5	0.2 ohms	"C"
	#6	"Infinite"	"B"
	#7	As above	
#4	#5	0.1 ohms	"C"
	#6	"Infinite"	"B"
	#7	As above	
#5	#6	As above	
	#7	As above	
#6	#7	0.1 ohms	"C"

Possible Problems / Solutions			
A	Excess resistance	Broken Bakelite Nut Holder or disintegrated fiber washer	
B	Excess resistance	Corrosion on screw threads	
	Infinite reading	Indicates a broken wire at one or more of these locations: • Screw #7 to electromagnet coil • Coil to capacitor bottom connector • Capacitor bottom connector to Clip #2 • Or if you are really unlike a burned-out coil.	
C	Excess resistance	Corrosion on screw threads	

16 Reassembly – Part 2

Install the "Moveable-Point"
Loosely install the Moveable-Point and all the associated pieces.

HINT: rotate the point so it is beside the Fixed-Point will make installing the screw much easier.

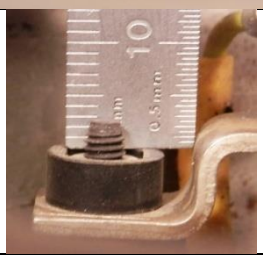
CAUTION: make sure the Bakelite ring goes through the center of both Fiber Washers.

- Push down and rotate Moveable-Point to perfectly align it with the Fixed-Point.
- Fully tighten Screw #3.

WARNING: If you can still shift the Moveable-Point sideways, either the Clip #2 or one of the Fiber Washers did not completely slip over the Bakelite Ring.

Adjust Screw #8 to its original height above the Bakelite holder, which you recorded during disassembly.

This will provide a good starting point, but probably not the final position.



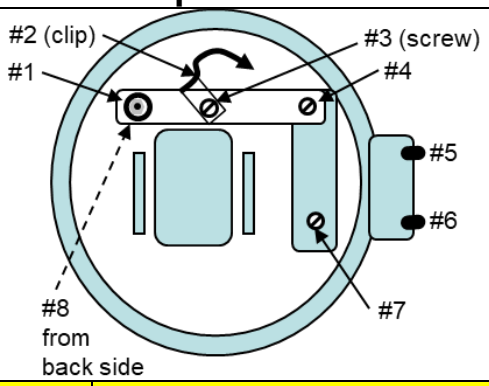
Verify wire clearance

- If using replacement disk capacitor, be sure its wires do not touch Fixed-Point Holder, Coil, or Main Cup
- Be sure wire from Capacitor Holder is not contacting the Main Cup (as was the situation with horn in photo). NOTE: all horns do not have the protective sleeve over the wire.
- Be sure the coil wire attached to Screw #7 does not contact the Main Cup.

Check near rim **Check at bottom**

Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net

16.1 Continuity Testing – with Capacitor Connected



Meter Lead 1	Meter Lead 2	Expected Results	Possible Problem
The following test is completed while pushing down on the Moveable-Points to **OPEN points**			
#5	#6	"Infinite"	Incorrect assembly of Moveable-Point
• The following tests are completed with the **points CLOSED** (their normal state). • Included are typical readings I have found. As necessary adjust your readings to compensate for the inherent internal resistance of your meter. They have been adjusted for author's Fluke 78.			
#2 Footnote [2]	#1	Infinity	"a"
	#3	0.2 ohms	"B"
	#4	0.2 ohms	"B"
	#5	0.2 ohms	"B"
	#6	0.9 ohms	"B"
	#7	0.9 ohms	"C"
#3	#4	0.1 ohms Footnote [3]	"D"
	#5	0.2 ohms	"D"
	#6	0.9 ohms	"B"
	#7	0.9 ohms	"B"
#4	#5	0.2 ohms	"D"
	#6	0.9 ohms	"B"
	#7	0.9 ohms	"D"
#5	#6	0.9 ohms	"B"
	#7	0.9 ohms	"B"
#6	#7	0.2 ohms	"D"

Possible Problems / Solutions			
A	Excess resistance	Broken Bakelite Nut Holder or disintegrated fiber washer	
B	Excess resistance	Clean points by drawing a piece of paper through the points. Verify your polishing retained a flat contact surface.	
	Excess resistance	Indicates a broken wire at one or more of these locations: • Screw #7 to electromagnet coil • Coil to capacitor bottom connector • Capacitor bottom connector to Clip #2 • Or if you are really unlike a burned-out coil.	
C	Excess resistance	• Clean points by drawing a piece of paper through the points. Verify your polishing retained a flat contact surface. • Corrosion on screw threads	
D	Excess resistance	Corrosion on screw threads	

[2] Be careful that the lead touches only the wire connector and not also the Stationary-Point holder.
[3] The Stationary-Point provides a direct mechanical connection between screws.

17 Reassembly Part 3 & Adjustment

Complete the assembly (aligning all the screw holes)
- Gasket
- Armature Plate with paint mark toward the Points and the armature parallel to the Fixed-Point Holder.
- Gasket
- Megaphone where the inner holes in "megaphone" line up with inner holes in "Outer cover"
- Outer cover
- Insert and tighten all screws.

- Connect ohm meter leads to Screw #5 and Screw #6
- If the initial reading of the meter shows:
  - resistance, then turn Screw #8 counter-clockwise until the reading is **"Infinity"**. What this does is raise the Point Holder until the Armature forces the **Points OPEN.** Then turn Screw #8 clockwise until it shows a resistance (**Points CLOSED**); plus turn it another 5 degrees.
  - "Infinity" (**Points OPEN**), then turn Screw #8 clockwise until meter is shows a resistance (**Points CLOSED**); plus turn it another 5 degrees.

CAUTION: use ear protection!
- Connect negative terminal of 12-volt power source to assigned horn terminal (see image below).
- Briefly touch a wire from power source positive terminal to the other horn terminal.
- Hopefully, you heard a very loud noise. If not, reverify the above step with ohm meter.

Seal the screw with a drop of hot wax.

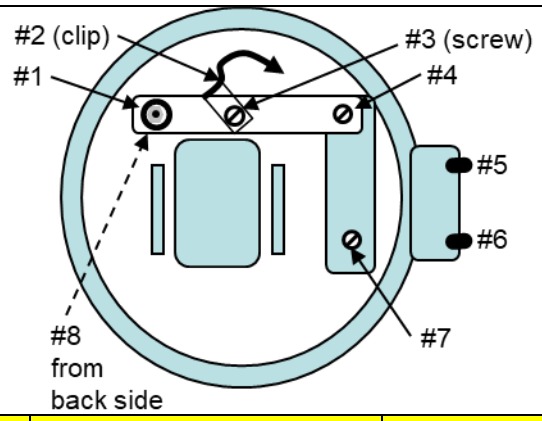
Install bracket. Note position of mounting bracket relative to the Bakelite harness connector on this unmolested 1964 Spider's horns.

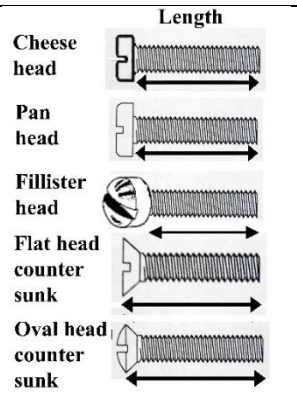
The 750 Workshop Manual shows the +12 volts connected to the electromagnet coil and the ground connected to the points.

This pattern has been observed on several Bosch horns.
The author is not convinced it matters, but why not assume Alfa, Marelli, and Bosch engineers know what they were doing.

- Ground wire (-): to electromagnet coil
- +12-volt wire: to capacitor

18 Hardware List





Item	Purpose	Description	Count	Size	Pitch	Length	Finish
1	Fix adjustment screw to point holder	Nut	1	4	0.7	N/A	Black
3	Fix capacitor wire and points to holder	See "Moveable Point" below					
4	Fix points holder to Bakelite (harness connection)	Slotted, cheese head screw	1	4	0.7	20	Chrome
		Lock washer	1	4	N/A	N/A	Chrome
5 & 6	Fix harness wires to horn (@ Bakelite)	Slotted, cheese head screw	2	4	0.7	5	Chrome
		Lock washer	1	4	N/A	N/A	Chrome
7	Fix electromagnet coil wire to Bakelite (harness connection)	Slotted, cheese head screw	2	4	0.7	18	Chrome
		Lock washer	1	4	N/A	N/A	Chrome
8	ADJUSTMENT SCREW	Slotted, oval head, counter sunk screw, with serrations on counter sunk side to prevent movement from vibrations	1	4	0.7	32	Black
NA	Fix cover to Main Cup	Slotted, fillister head	6	4	0.7	6	Black
N/A	Grommet – interior harness wire Bakelite	Rubber	2	See diagram below			

Stationary-Point

Bosch HO/FDG: Stationary-Point & hardware

(#1) Nut 4 x 0.7
Bakelite

4.3 x 11.2 x 1.0 red fiber
4.3 x 7.8 x 1.8 steel disk

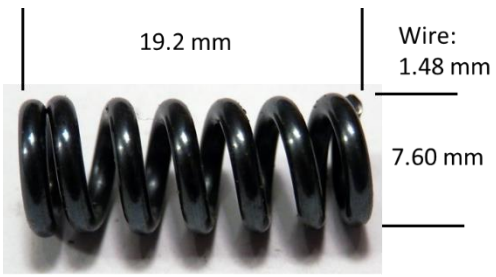
Spring
4.5 x 10.8 x 1.8 steel cup
3.9 x 10.0 x 2.0 neoprene seal

(#8) 4 x 0.7 x 32
oval head, counter sunk screw

(#4) 4 x 0.7 x 20
Cheese head screw

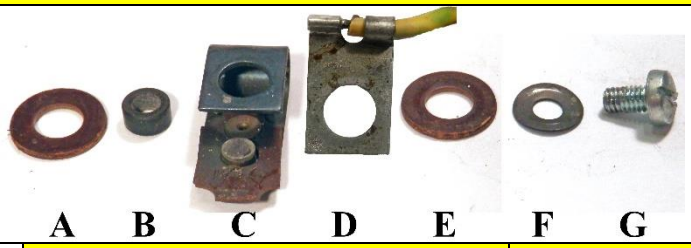
Lock washer

Holder



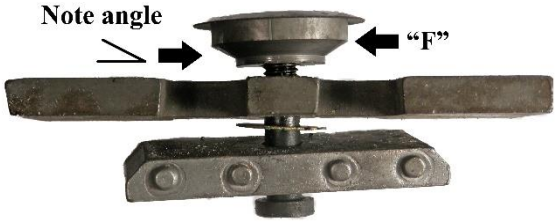
7 coils, ends are not ground flat

Moveable-Point



		4 mm Version	3.5 mm Version
A	Fiber insulator	6.02 x 11.96 x 0.83	5.96 x 12.0 x 1.0
B	Bakelite insulator	4.16 x 6.00 x 2.84	3.71 x 5.96 x 3.20
E	Fiber insulator	Same as "A"	Same as "A"
F	Steel washer	4.50 x 8.18 x 0.68	3.75 x 8.85 x 0.47
G	Screw	4 x 0.7 x 6	3.5 x 0.6 x 5

Diaphragm/Armature



Item	Purpose	Description	Count	Size	Pitch	Length	Finish
A	Fix all components to plate	Phillips, thin cheese head, partial threaded screw	1	6	1.0	30	Black
C	Shim washer Footnote [4]	Disk	1	6.2 x 14.7 x various			Brass
E	Shim washer Footnote [5]	Disk	Various	6.2 x 14.7 x various			Brass
F	Spacer	Machined shape	1	See diagram			Footnote [6]
G	Gasket	Molded shape	1	See diagram			Footnote [7]
I	Spacer	Machined shape	1	**6**	**1.0**	N/A	Footnote [8]
J	Gasket	Machined shape	1	See diagram			Footnote [9]
K	Nut	Nut • Most 10 mm wrench • Some 11 mm wrench	1	6	1.0	N/A	Zinc

[4] Some horns had one spacer between B & D; with other having a 2nd spacer or spacers between D & E.
[5] Some horns had one spacer between B & D; with other having a 2nd spacer or spacers between D & E.
[6] Some were cast iron and others were CAD (yellow) plated steel.
[7] With some horns using rust prevention paper and other using plastic.
[8] Some were cast iron and others were CAD (yellow) plated steel.
[9] Some were cast iron and others were CAD (yellow) plated steel.

Hardware

"C"

Examples found:

- 0.58
- ... lost list of others

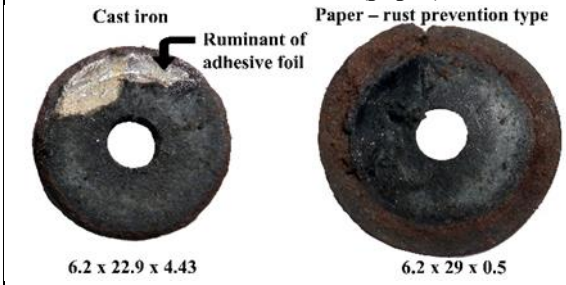
"E"

Examples found:

- 0.65
- ... lost list of others

"F" & "G"

"I" & "J Version 1 (paper)



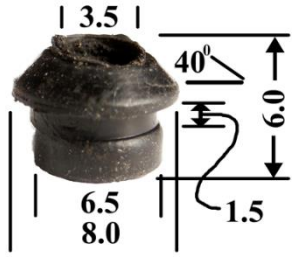
I" & "J" Version 2 (same as "G")

Miscellaneous

Wiring Harness Connector

Details of grommet at right

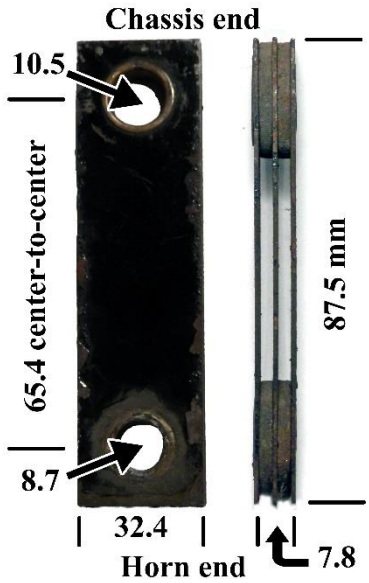
Grommet



Hardware

Mounting Plate

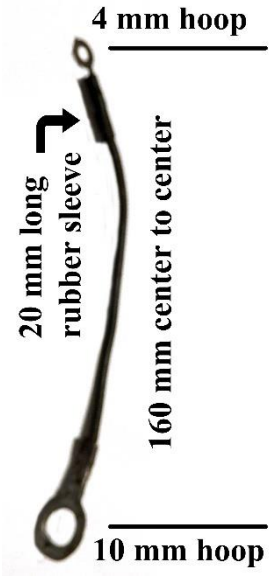
("Leaf spring holder" in Bosch terminology)
These measurements are from HO/FDG horn



Item is not listed in Spare Parts for HO/FDG, but it is for predecessor horn (HO/FSA) with a Bosch # of HOBE-4-G-3Z (no Alfa #)

Ground Strap

These measurements are from HO/FDG horn



Ground wire not listed in Spare Parts

Mounting Plate							
N/A	Fix mounting plate to horn	Nut (14 mm wrench)	1	8	1.25	N//A	Black
		Lock washer	1	8	N/A	N/A	Zinc

Originally provided by Carl R. Davis
Send correction to carl750@sandprairie.net