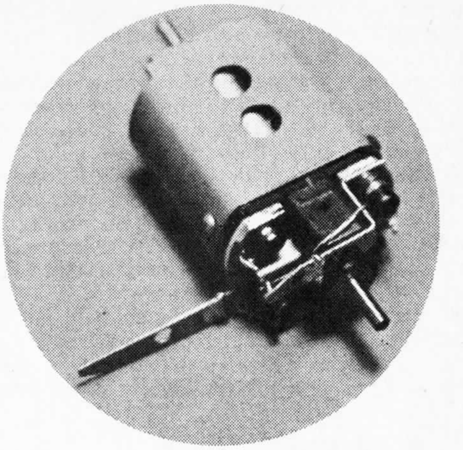
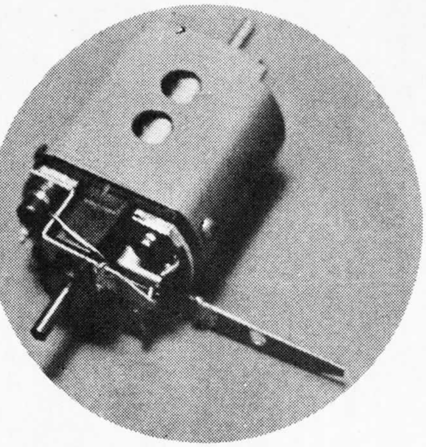


TO MY FRIENDS AT THE CERTUS CO., I DEDICATE THE FOLLOWING ARTICLE. WITHOUT THEIR FINANCING AND FAITH, BOB GREEN AND MYSELF WOULD NOT HAVE BEEN ABLE TO GO ON IN THE MOTOR DEVELOPMENT THAT GAVE BIRTH TO SUCH HOUSEHOLD SLOT CAR PRODUCTS AS THE GREEN CAN AND PRECISION SLOT CAR RACING MOTORS. THE THINGS WE LEARNED OVER NEARLY THREE YEARS OF BUILDING AND RACING CAN'T BE PASSED ON IN A ONE SHORT ARTICLE BUT IF ANYBODY CAN LEARN FROM THIS OFFERING HERE, I GUESS IT ALL DIDN'T GO TO WASTE. THANKS, CHUCK



IT ONLY TAKES two things to build a great racing motor and I'll bet that you can guess just one. Workmanship is the most important physical thing we will have to overcome, and if you can master the most important mental thing; call it attitude, the physical stuff will be easy. To have the correct attitude you are going to have to learn some theory, so sit back and forget everything you ever were taught, learned, or were ever told about slot car motors. What you are about to read is truth in the form of Gilbert/Green Motor Theory. I blame most of what I think I know on Bob Green and what we learned together during the development of the Green Can and Vulcan Arms. Again, this article contains no tricks or mysterious formulas, just a lot of common sense that may be totally uncommon to many home-grown motor wizards. Listen to me; you'll win.

What makes a good motor? Torque? Top-end? Brakes? Reliability? All of these in the right proportions make a good motor. We'll be working with the particular variables that we can control these performance basics with, like cans, magnets, over-the-counter arms, etc. If you've run on more than one track you must know that a different percentage of each performance basic is required in a particular motor to take the best advantage of a track situation. More simply, a missile motor on one track might be a total load on another.

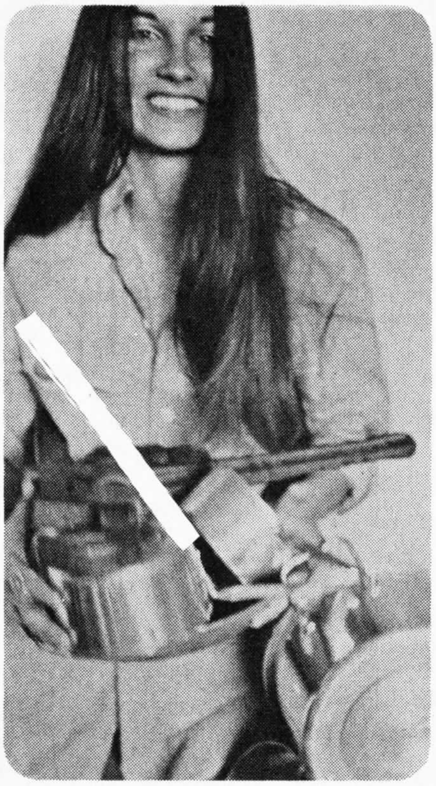
To find the right motor for a track what is the first thing we fiddle with? Arms, right? WRONG. Armature selection is important, of course, but cans and magnets are the main things that control the performance basics. I hope this will explode any misconceptions on your part. From what I've proved to myself, a small change in a can/magnet combo will have more effect on motor performance than anything else outside of turning off the track's power. This being a good time, let's talk about cans.

What makes a good can? The most important variables are material, hole pattern, height and width. Most of you will agree that a good quality magnetic field conducting material is best, right? WRONG. We need a semi-garbage metal and right now Mura has it. Don't ask why just now. To answer that one I'd need a book. Hole pattern should be designed for cooling the arm and still allow the maximum magnetic field flow, right? WRONG. Bob Green and I tried every hole pattern you can imagine and more. Believe me, Mura has the best. I've blown a few hundred arms to prove that. If you've got the time and the bucks, go ahead and prove me wrong. The holes do aid cooling but only as a side effect to trimming the magnetic field (flux) flow to a usable level. Excess flow causes

EVERYTHING YOU'VE ALWAYS WANTED TO KNOW ABOUT SLOT CAR MOTORS*

* But were too dumb to ask.

by LEE GILBERT



"Dona would like to point out to all of you that these articles take no special tools; especially when you have a mind like hers. Empty your pockets and kitchen cupboards and let's get to work."

disaster in permanent magnet motors. Can height also regulates field flow. The best height is 0.555". The Green can is 0.563 thanks to the fact that most of us have to use production magnets. Don't worry, this height will work. The amount of gain in chopping a can and magnets isn't really worth the gain in horses so forget that idea right now.

That is all you need to know about cans at this stage and don't let the gaping holes in this explanation bother you. Go along with me for awhile before you condemn me for life. What I'm talking about works; textbooks haven't yet been written for this area of electromotives. In case you haven't guessed by now, I recommend the Green can 100%. This is the only one ever produced that has been race tested before going into production. Something that should be the rule with racing products instead of the exception. I've tried several other cans but none gave me the most consistent number of performance basics as frequently.

Now on to magnets, the choice being DZ's, Blue-Dots, or Black Power. There isn't much to be said here except that I've used all successfully but prefer the Black Power simply because they are easier to sand. The quality of the Black Power magnets means a lot less work, and I'm all for that. The Black Power and Blue-Dots are the most powerful choices but please remember that your can is the most important factor here and magnet strength is neat but not critical. Two things are critical on magnets regardless of type and you don't want to be a hatchet man on these. Most important is to have them zapped before every race and second is to sand all surfaces smooth to achieve consistant air gap and better seating of the magnet in the can. A good zap cannot be over emphasized. The only place I know that gives good magnet zaps is Ron Granlee's Speed & Sport Raceway, at P.O. Box 39, Buena Park, Calif. 90621. You can have an unbelievably good set-up but it will be wasted without a good zap. Performance and reliability go down proportionately with lack of zapped magnets no matter how strong they feel. If you don't sand your magnets your measured and actual air gap will be two different things. The air gap is the measured distance between the magnet surface and the armature plates. The best results in performance come from an air gap of .005" to .009". More on air gap later. The best thing to do is just fiddle and find what works best for you on your track.

To sum up cans and magnets let me remind you that too much field is the greatest cause of poor performance. This is contrary to what most people say and think these days but it's true nonetheless. Luckily for me, most people were just saying and believing . . . when I was doing. Try my way and I'm certain you will be rewarded.

Armatures. Most of us don't wind our own armatures and I hope to discourage that inborn desire to do so right now. I prefer arms wound on Mura or Thorp blanks because they have the best design and material for the can/magnet situation I just discussed. Below is a rough list of how to select an arm for your track if there isn't a current hot one that you know about. Even if there is a favorite, look this over.

If your track has:	*Try this armature wind:*
Good Battery Power	*24 or 26–27*
Medium Battery Power	*25 or 27–28*
Poor Battery Power	*25 or 27–28 or 26*
Good Power Pack	*25 or 27–28*
Medium Power Pack	*25 or 27–28 or 26*
Poor Power Pack	*26 or Grp. 20*

If you are curious about timing you'll be interested to know that most manufacturers have that down pretty good now and you should be safe laying bucks down for just about any little goodie. It's always fun to hand pick your own race arm from several in stock. I always look for the best workmanship (that sort of thing turns me on) but in reality there is no sure way of picking one hot arm over another. Some will be rockets, some piles and some in-between. As soon as the armature boys figure that out you won't have to take pot-luck but for now the best bets are: Pooch, Vulcan, Steube, or Thorp. There are other good arms too but with these four I've had enough experience to be confident.

I didn't really hit on lamination thickness or stack length or diameter of an armature because we'll just be buying one over the counter. All of these things affect armature performance but you and I have no control over what the arm boys are doing so we shouldn't even worry about it. Just stay clear of super short stacks or super long ones. Be mediocre. One more thing about arms. Always keep them in balance and have the commutators trued. When the thing slows down (usually after one or two good runs) send it off to Proto or Camen Balancing Service.

Brushes and springs are next on the agenda and if you are getting weary at this point go out to the kitchen and grab a Coke while holding your eyeballs under the cold water faucet.

The best brushes to use are the old Mabuchi 36—D's. These can be found in old 36—D motors. There aren't many of these things left but if you know of a shop with a museum you may be in luck. If not, use Mura's. They are the most consistent and you always know what you are getting. That is seldom the case with some other brands. Play this safe. You don't want a cheap set of motor brushes messing up your investment.

On motor springs I've found the three-coil Mura's to be the best (M—97). If you can't get these try the new MPP stuff. I don't use a fiddlestick or any other trick nazi. Bend MPP's to 110 degrees or M—97's to 90 degrees for the best results. Too little brush tension is far worse than a tad too much. This angle can be best sighted with the spring on the motor before slipping it behind the spring retainer tab. These ideas are fairly standard and not over critical as some people seem to think. Just keep it in the right ballpark and you'll be fine.

Armature spacing between the two shaft bearings has never really excited me a whole lot. Monty likes about .020" slop while I dig zero slop as long as the arm spins freely. I prefer close spacing due to the fact that the thing wears nearly .002" for every ten minutes running anyway and I like the brushes to ride on the narrowest track possible. What this breaks down to is that armature spacing isn't really an important item. Don't lose any sleep over it. Just make sure that the arm is centered in the magnetic flow of the can before shimming.

Ball bearings are one of the most overmphasized motor magic bits of our time. To sum that up quickly: I don't believe in magic. The only thing I've ever noticed about using them was the fact that my wallet always seemed thinner. In reality they hurt braking but keep the motor a little cooler. The difference isn't worth a dime let alone the cost of BB's.

Shunts for the motor brushes are sometimes overlooked. Don't you. It's a simple matter of resistance. Come on man, let's get some juice to the thing.

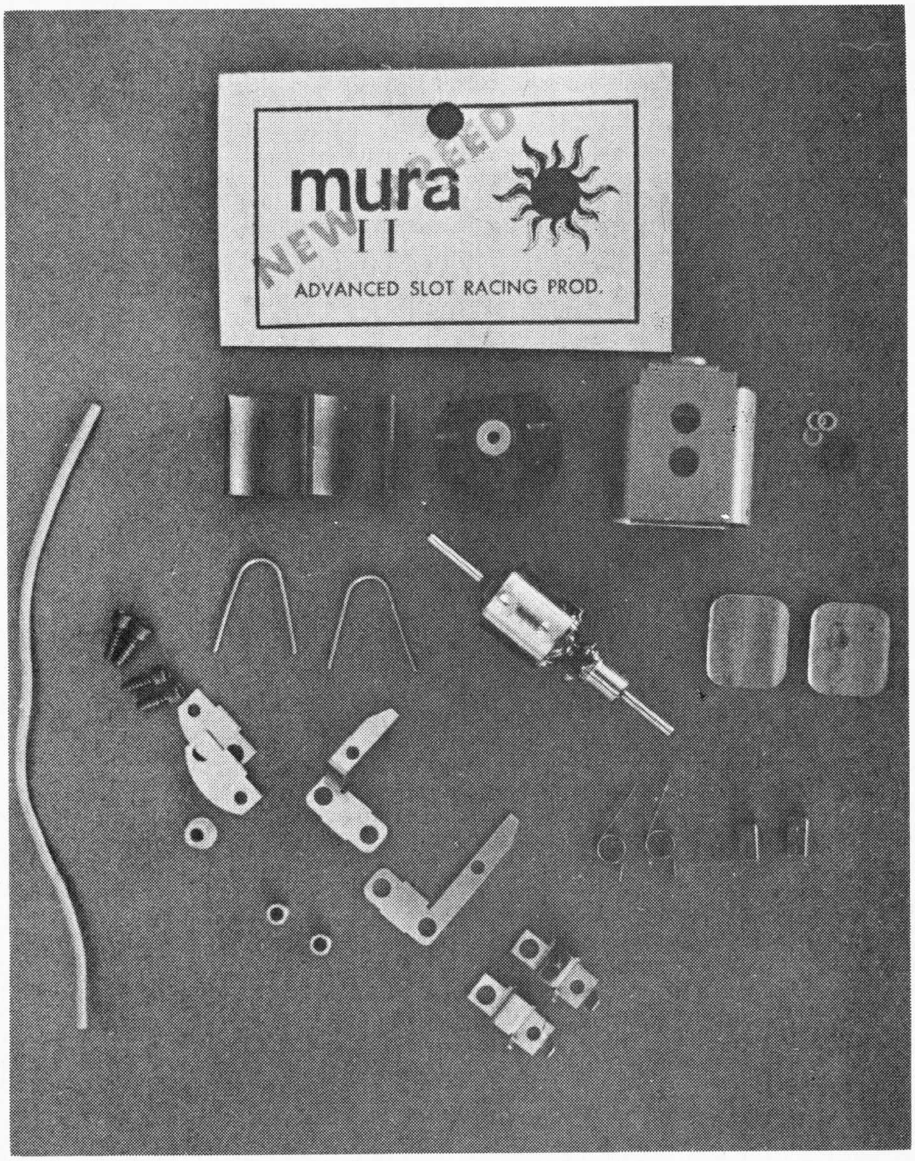
Here are some important things to remember when following this building article. In order of importance we should first try to be consciencious in attaining good workmanship in our motor building. This comes only one way: with lots of hard work and practice. Secondly comes some of the techniques that really help in

PARTS LIST

1 Mura II Green Can
1 Mura II Endbell Kit
1 Set Black Power Magnets and clips
2 Champion .004" magnet shims
1 Pooch 25 armature (or what you think best for your track situation)
2 Mura M-97 brush springs
2 Mura 36-D motor brushes
1 Package Mura .007" brass armature spacers
1 Mura fiber washer
4 Mura pin tabs and drill bit
1 Piece Riggen leadwire (orange)

(SPECIAL TOOLS TO BORROW)

1 Mura Alignment Tool
1 Semi-workable Caliper



perfecting good race motors into great ones. Alignment of everything on the whole motor is a good thing to become proficient at. Start with the brush hoods and work around to the whole endbell/can/magnet relationships. Next is to select good motor parts. This is easily done with some experience at the drivers panel and a little common sense. Just remember that high-dollar or new trick units aren't necessarily the way to go. Buy from a little experience and with a little common sense. The fourth item of importance is having good zapped magnets regardless of their code name or number. The fifth thing to keep in mind throughout is cleanliness. Dirt is a bummer. If you have time, the last thing you should always do to insure that your latest missile motor is just that, a missile; try praying. At least you'll have somebody to blame if things go sour.

In the beginning of this theory session I said something about the correct combination of things (performance basics) that would lead to an inevitably strong motor for your particular situation. Now I'll try to bring all of this cram theory course together for you. A super correct combination of performance basics may not mean ultimate horses or brakes or top end. The right amount of each of these things is needed. Torque is neat but what can you do with a car that jumps out of the slot or breaks its tires loose all the way down the straight. Top end is cool but not if you have a track with long straights of less than ten feet. Can you see what this combination thing is all about? Design your motor for your track and chassis. You can't win a race by spending time on the floor or in a turn marshall's hands.

Here's how most of the individual performance basics affect what a motor has or doesn't have in the end. Torque for short means brakes and generally low end. We have several ways to control torque. For less torque we can use an armature with fewer turns of wire (an MPP—Vulcan) or move your magnets out to increase the air gap by about two or three thousands. I think you can see the easiest to play around with. More torque can be had from doing the opposite things (try a Steube arm). The smoothest motors I've run always seem to be 27—28's. with .008" clearance; whatever that means to you.

Experiment with different set-ups and don't become discouraged by some nut with a weird car that passes yours down the straight. Dragsters are neat, of course, but lap totals win races . . . not impressive bursts of speed down a straight. One other thing not to concern yourself over is the reliable motor that can last for two years. I figure an hour is plenty. That's enough time for a main event with enough cushion to handle a situation where qualifying may dump you in a semi. If any of us do worse than that in qualifying we should forget winning for that day anyway. They say that winning isn't everything but losing is nothing.

Future trends in motors are already showing signs of reverting to the past. New self proclaimed motor wizards are repeating many of the errors of yesteryear just because their 1972 textbooks were written for engineers. No matter what anybody else says, *I* know that slot car motors left the textbooks in the weeds years ago, and I've yet to see any engineer truly understand them. Use what I've thrown out to you in very small doses and you can't go wrong. Listen to anybody else and you may find yourself using all sorts of fancy face-savers for things that should have worked but don't.

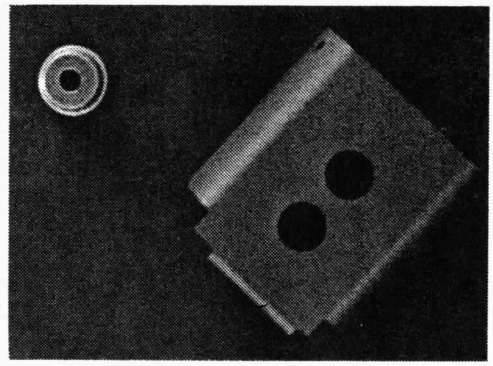
What the future should hold is the development of an all new small motor that would allow a higher degree of chassis experimentation. Don't expect that to happen until our sport becomes rich enough again to handle the costs of such development. When, and if, this does come to be I'll be in the wings to let you know whether or not it was done right . . . don't fret!

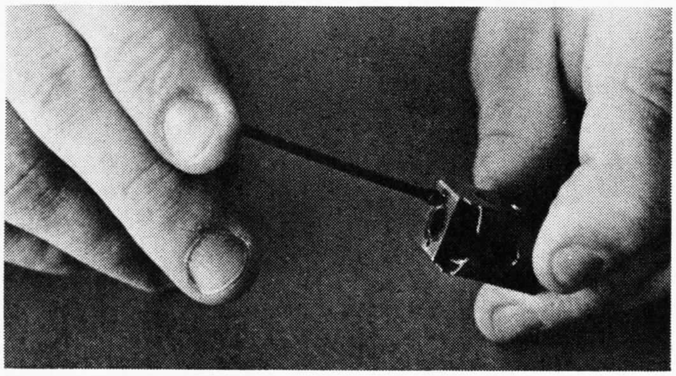
I think that now is the perfect time to leave you with probably the greatest single statement ever to come out of the resident California motor wizard: Bill Steube Sr. This was taken from his recent comments in the *Grundy Gazette.* "The design and manufacture of slot car motors is a science of vague assumptions based on debatable figures taken from inconclusive data, obtained with equipment of problimatical (?) accuracy by persons of doubtful reliability and questionable mentality." Right on, Bill!

Handy hints for those of you that have time to fiddle.

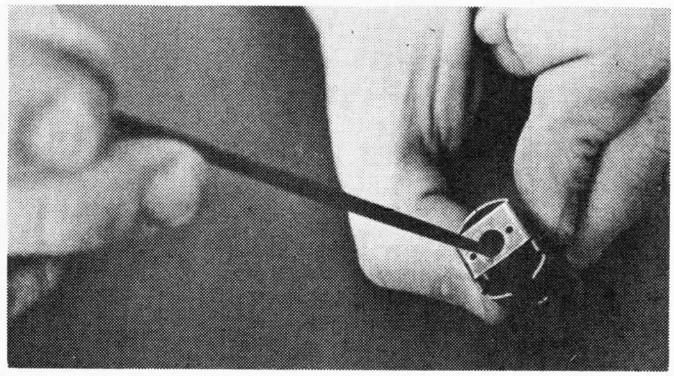
One fun thing to do that really impresses endbell freaks is to thread (tap as it were) all of the holes for brush hood retainers, spring posts and endbell mounting tabs. Use 0-80 tap and screws for the endbell mounting holes and 2-56 stuff for the other. Most good hobby shops stock goodies like this for their customers and sometimes even hardware stores will have them. This action makes maintenance a breeze and it looks pretty sharp too. One other thing you might try if your motor seems to be power robbed with other cars on the track is to shim the top and bottom of each magnet with .003" brass. This cuts the field a tad and will allow the motor to run on less power at a decent speed. This trick is usually something to try if your track has fairly grim power in the first place but don't expect to make a totally sour arm perform.

STEP 1 Lightly tap the can bearing out of the can. Be gentle.



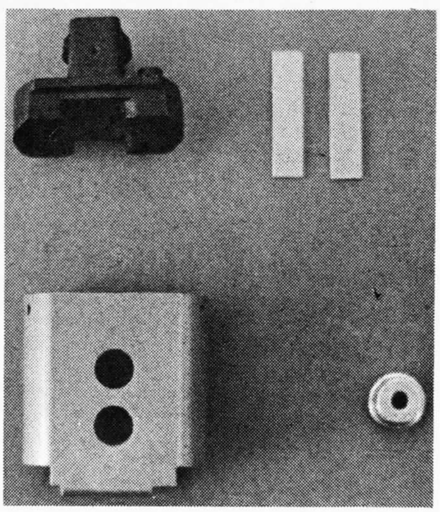


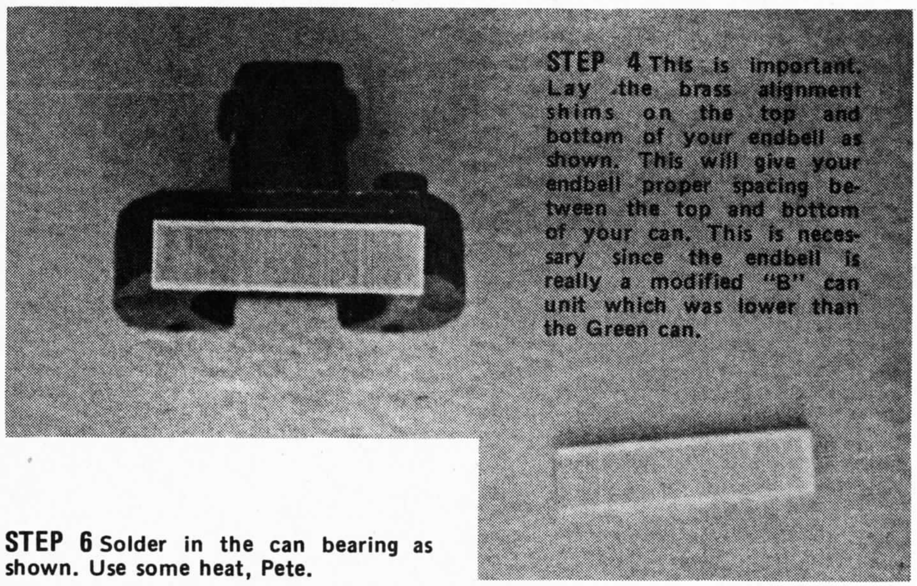
STEP 2 Grab one of the self-tapping motor screws from your endbell kit and thread only the top hole of your can. We have to do this now to keep the can bearing in alignment later.



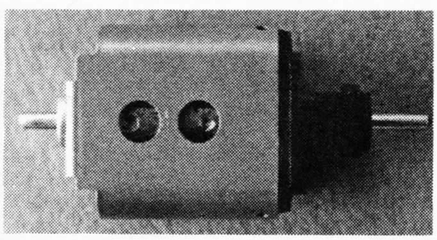
STEP 3 Lightly file the can bearing hole so that the bearing will just drop into its lip without any help from your muscled fingers.

Gather up your endbell and alignment brass shims with your can and bearing.



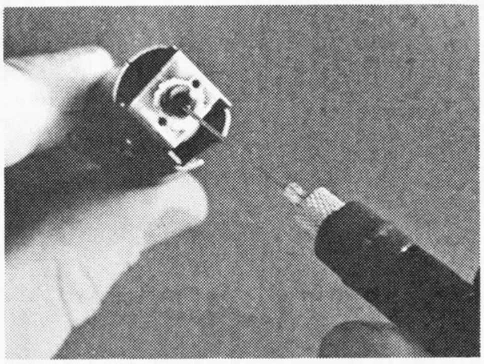


STEP 4 This is important. Lay the brass alignment shims on the top and bottom of your endbell as shown. This will give your endbell proper spacing between the top and bottom of your can. This is necessary since the endbell is really a modified "B" can unit which was lower than the Green can.



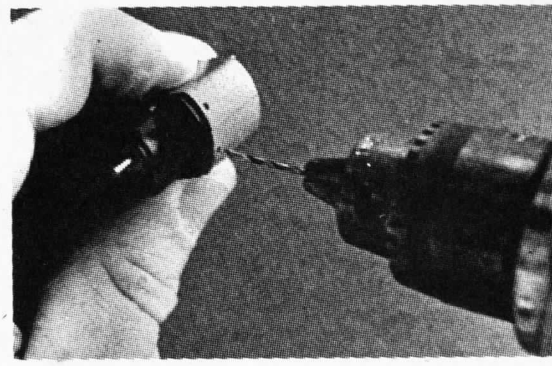
STEP 5 Drop the can bearing in where it belongs with an old coughed arm (or one you wished to heck you never bought). Next, insert the endbell with the shims into the can. The kit endbell should already have the endbell bearing pressed inside. Do it straight and neat.

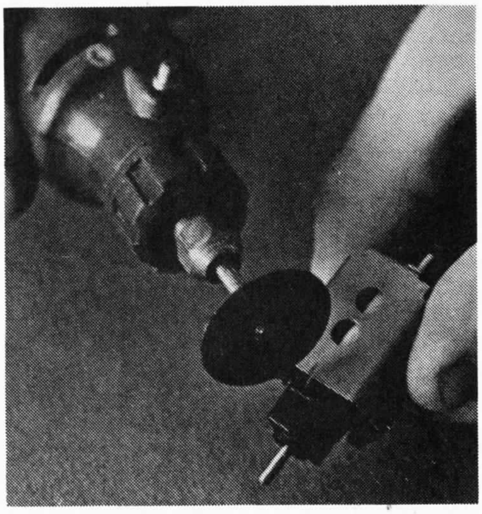
STEP 6 Solder in the can bearing as shown. Use some heat, Pete.



STEP 7 As soon as the bearing is soldered in hit it with the oil can. Most of the oil already in the bearing boiled out and must be replaced.

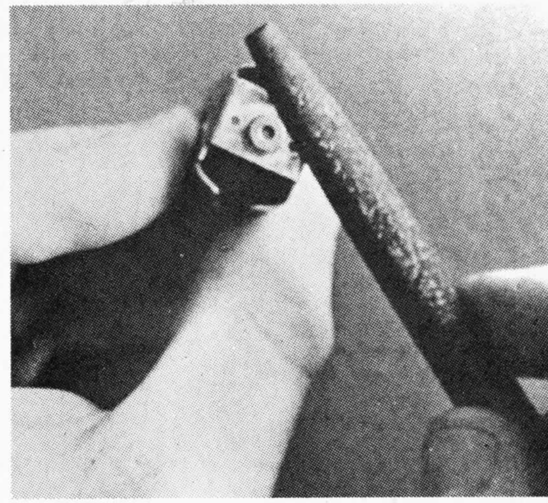
STEP 8 Now's the time to drill your pin-tab holes. If you are uncool with a drill as I seem to be, you'll be glad you used an old arm.

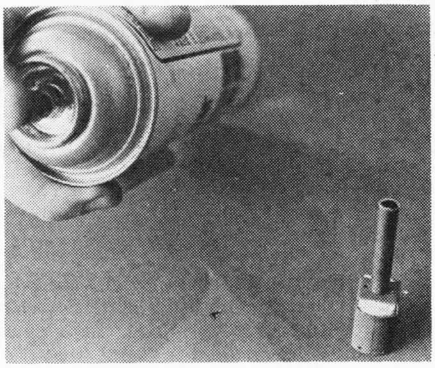




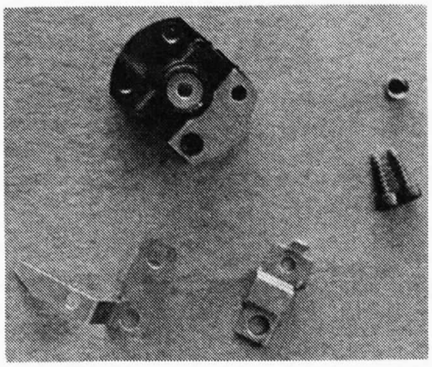
STEP 9 To aid in alignment of the can to the endbell make a small nazi (scratch or mark) on one side of the two as shown.

STEP 10 Remove the endbell and arm. Clean up your messy soldering job with a little filing and scrubbing.



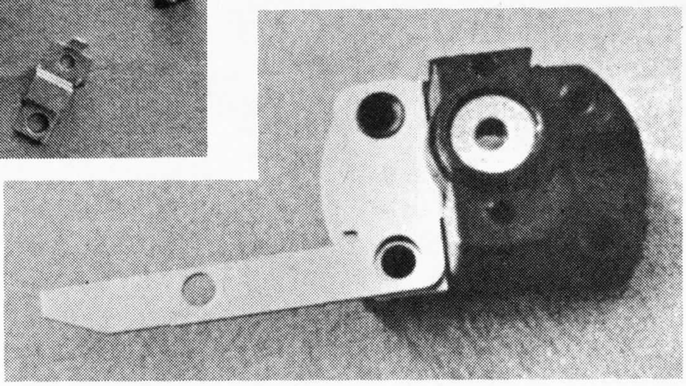


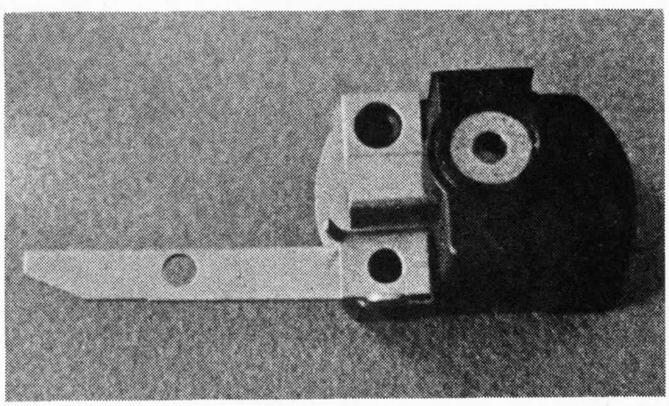
STEP 11 Now we should paint the can . . . but first fill the inside with tissue paper and cover the outside of the can bearing with a chunk of 1/4" tubing as shown. As soon as you have all of the critical areas protected paint the can any color that turns you on; I prefer a meek shade of magenta.



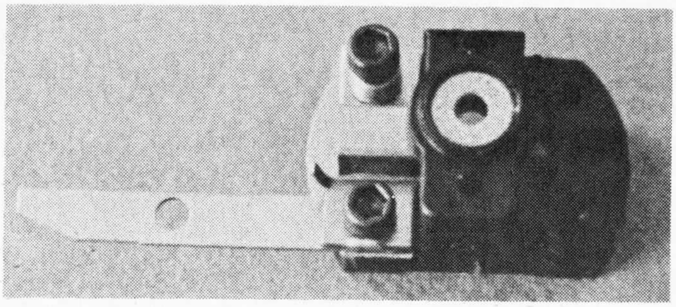
Scrape up your endbell goodies and make sure you haven't inhaled any vital unit.

STEP 12 Start building this side first. Lay the heatsink (that aluminum thingie), then the buss bar thingie down on the endbell as shown.

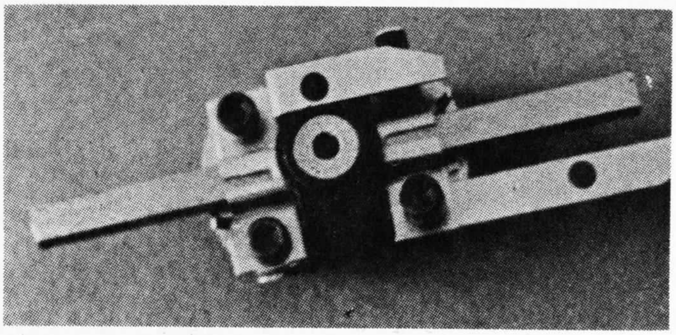




STEP 13 If you look closely at this picture you will notice that the brush hood looks stock. That is because I was keeping an eye on my Girl Friday when I should have been cutting a slot on the top of each brush hood. The slot is designed for a better shunt wire system. This picture was taken prematurely but the slots will turn up later. Don't forget to cut yours now. Hold each hood with a pliers and be gentle with your Dremel. Once the hoods have been notched and filed free of any burrs, go ahead and lay the unit on top of the other endbell parts as shown.

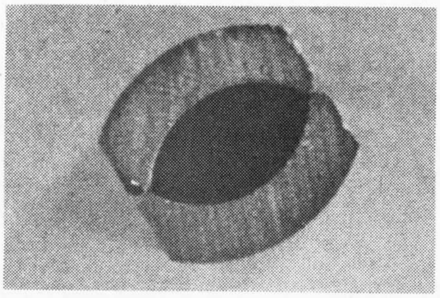


STEP 14 Cram the screws in the holes as you've always done before. Keep them loose for a moment. Remember to keep the screw collar on the proper hole/post (the one opposite the buss bar for this side only). Going on, just do up the other side neat too and keep it loose for a moment also.

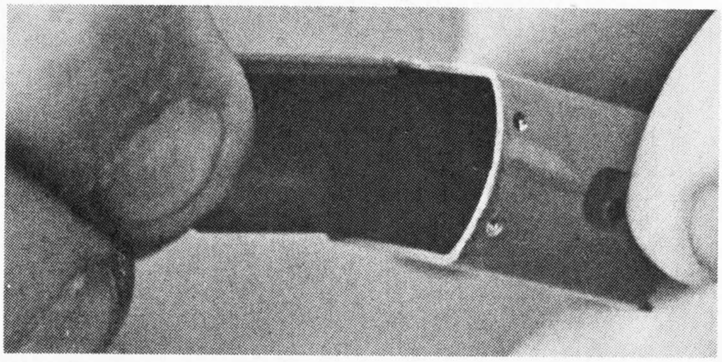


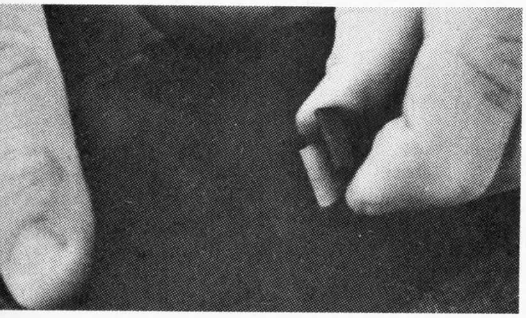
STEP 15 Slip a Mura alignment tool through the brush hoods and eyeball the thing in parallel to the top and bottom of the can. Tighten the screws down. Don't forget to remove the alignment tool and return it to your buddy.

In case you have forgotten, this is what magnets look like.

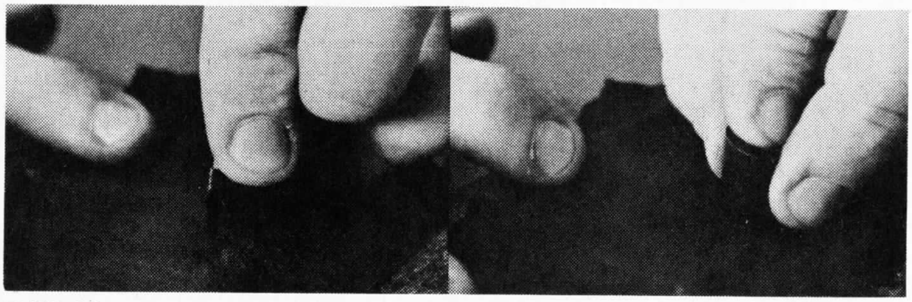


STEP 16 See if you can stuff these beauties in your can. Do they fit?

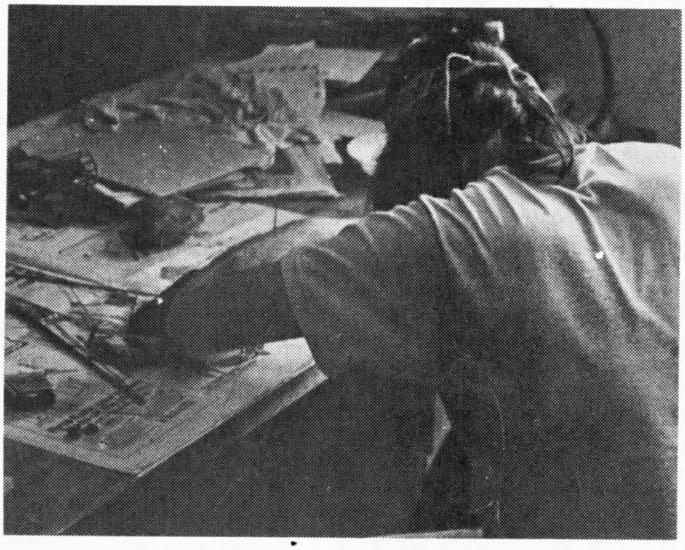




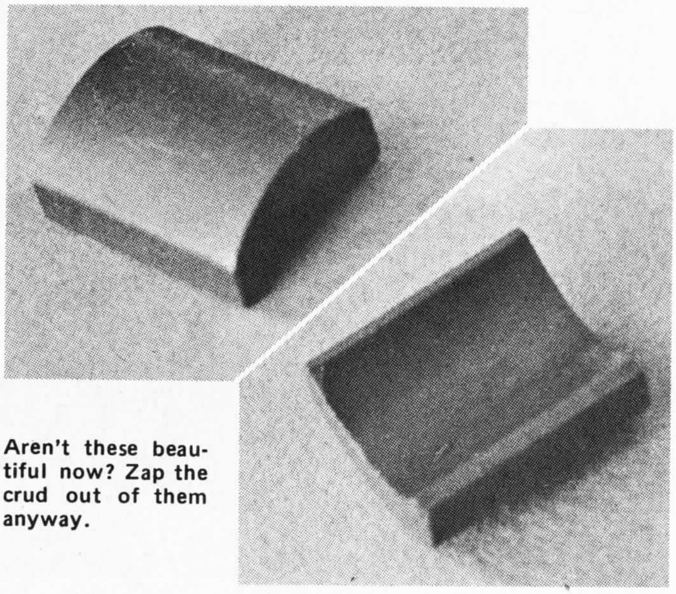
STEP 17 If the magnets stuff a little hard today, sand the tops and bottoms a little with some decent 250 grit sandpaper (aluminum lasts neat).



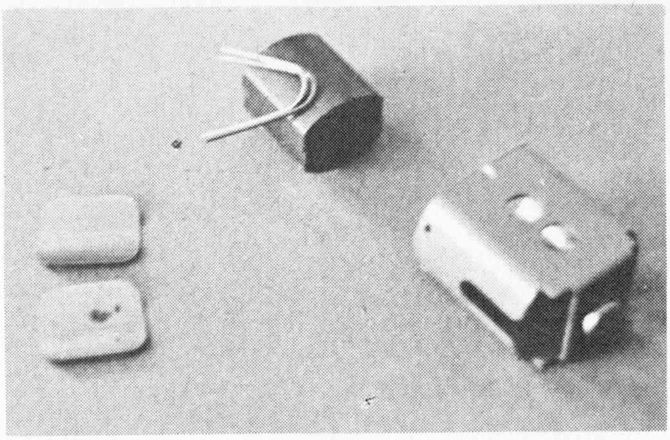
STEP 18 Sand the face, back, and ends of the magnets while you're at it (it's hard to stop once you get going). The best way to do the faces of the magnets is to use a half inch dowel with the sandpaper wrapped around it. I can never seem to find a dowel that size but an X-Acto handle is a good way to fake it. Sand those little babies until you can see your face in them. Wipe clean with a damp cloth.



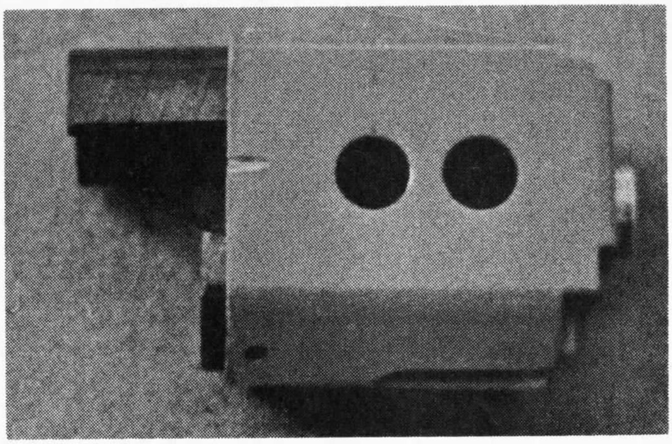
Sand, sand, sand. See the idiot do it!



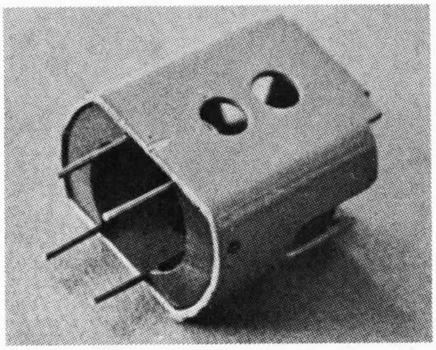
Aren't these beautiful now? Zap the crud out of them anyway.



STEP 19 Scrounge up your shims, magnet retainer clips and can.

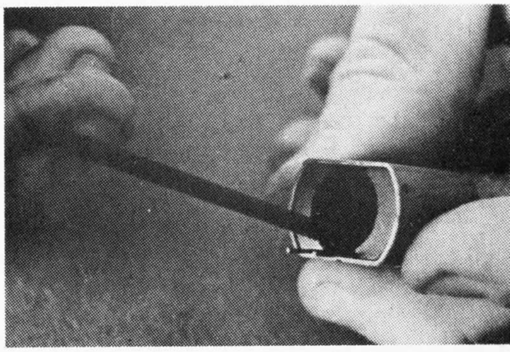


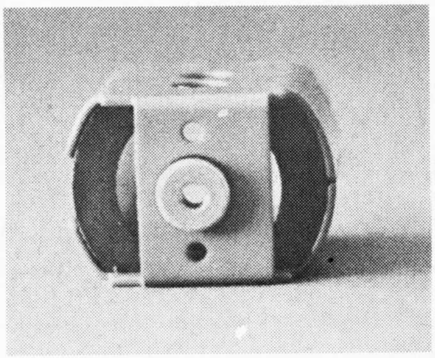
STEP 20 Slip the magnets in the can without the shims for now.



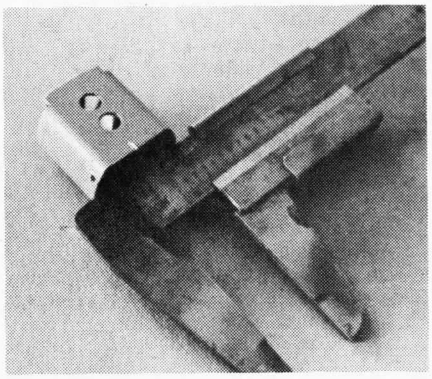
STEP 21 Insert the retainer clips.

STEP 22 Jam them all the way back with anything handy. Now is a good time to check the distance between the magnet faces. We want .0075" air gap on each side of the arm. My armature is .510" so the distance between the magnets has to be .525". Use your calipers to check that.

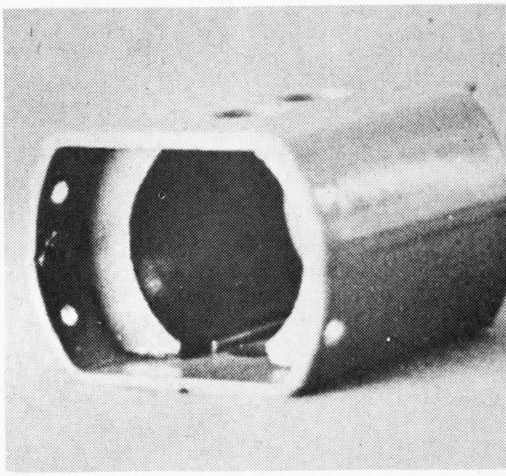




STEP 23 There was too much clearance on my set-up so I crammed the Champion shims in behind the magnets. Shove the whole works back into the can flush with the end of the can sides.

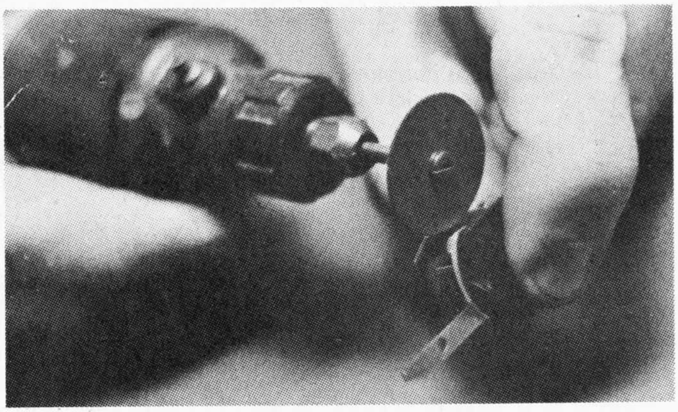


STEP 24 Check everything again now. Mine worked out right but you may have to fiddle with different shim thicknesses if you haven't followed instructions.

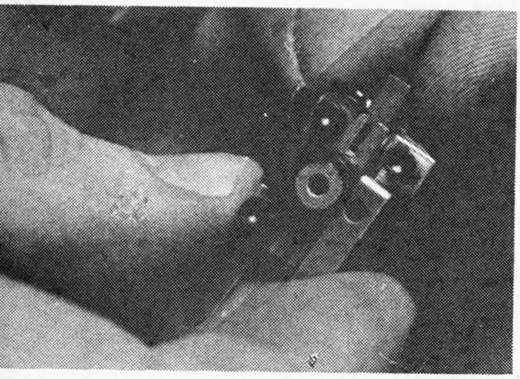


Isn't this a sight to behold?

Remember, cleanliness is Gilbertness. Had to find *some* reason to get her picture in again.

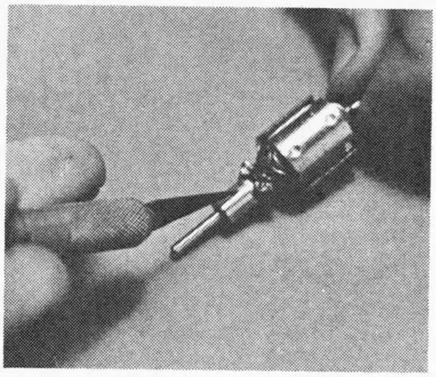


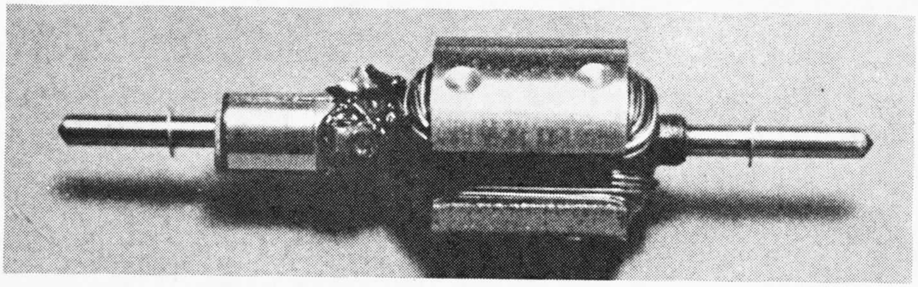
STEP 25 There are a couple extra tabs on your endbell so go ahead and trim away anything not needed.



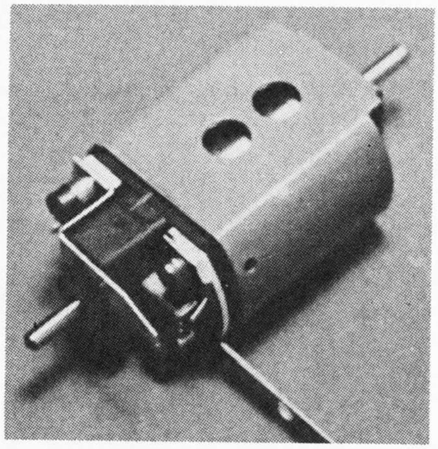
STEP 26 Drop your motor brushes through both sides of the endbell brush hoods. If they fell freely through like mine, you won't have to pick up a square file and file the brush hoods to death. Don't overlook this critical step that even pros slip up on once in awhile. It'll save your bod heartache later.

STEP 27 Take a sharp X-Acto knife and clean the comm slots on your armature. Don't slip here. You'll definitely screw up the works or bleed all over the table.



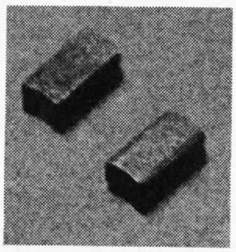


STEP 28 Stick the fiber washer on the commutator end of the armature shaft and jam as many .007 spacers as you need to center the arm. I hope you read the text.

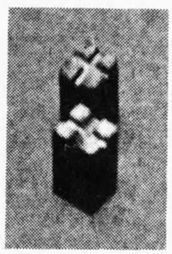


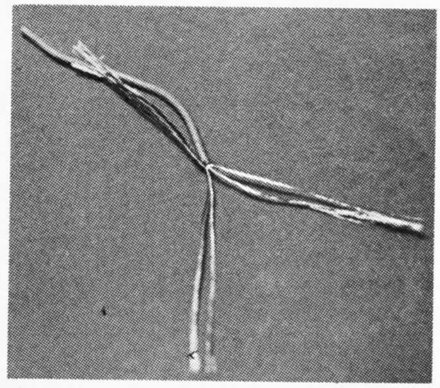
STEP 29 After you've accomplished this centering jazz, beat in the pin tabs even though you don't see them here. Can't you do anything on your own?

STEP 30 Now for the brushes. File the sides in the manner shown. One is filed and one is stock. You'll have to do the other one yourself.



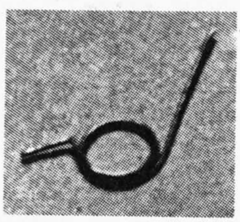
STEP 31 Notch the spring end of the motor brush as shown. If this looks like a positive plus as opposed to a negative minus, you really must be on the ball today.



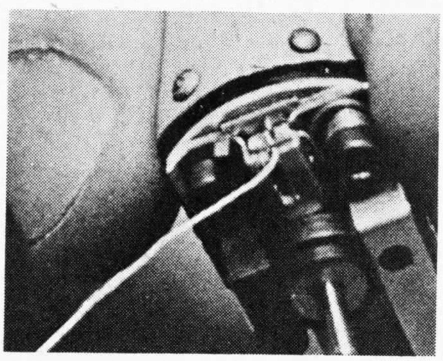


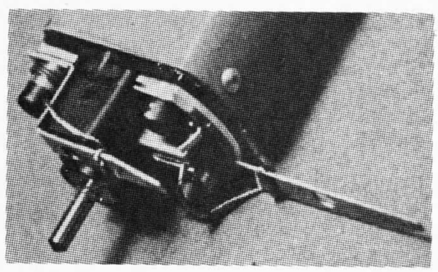
STEP 32 Now for the shunts. We'll use some good Riggen lead wire for this purpose so strip some of the insulation off of a piece right now. Inside, you'll find six strands of twisted smaller wire. Twist two of these bigger strands together for each shunt. Make just two shunts.

STEP 33 Get bent (at 90 degrees), you brush spring.

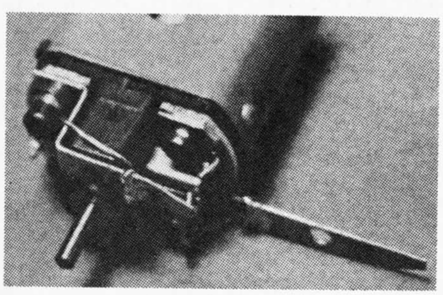


STEP 34 Drop your modified brush in and lay the shunt wire in place as shown. Clamp the works down with a brush spring.





STEP 35 Wrap the loose end of the shunt wire around its corresponding buss bar. Leave some slack, Jack.



STEP 36 Solder the shunt wrappings lightly. Ease off on the acid and heat.

Touch the front and rear bearings with some oil. That's it.