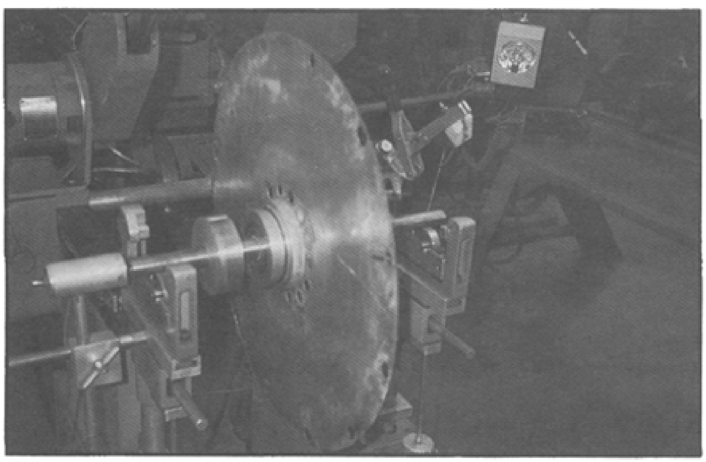
Balancing Technology

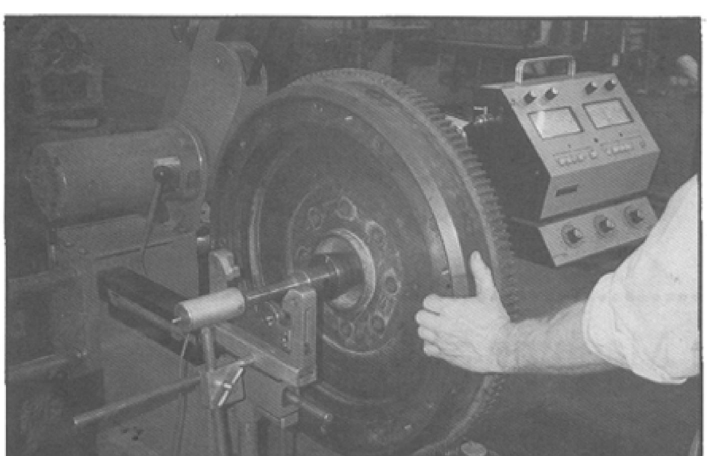
John Bianchi & Gary Hildreth

While looking at these graphs, charts and overheads, keep in mind that your per hour rate is considerably more when dealing with the industrial side of balancing. We will be discussing the time it takes to do these jobs. The time given will include both set up and tear down. We are not trying to tell anyone what to charge. We are merely pointing out the value added to an industrial customer. Experience has shown a return of approximately 2 to $2^1/_2$ times shop rate.

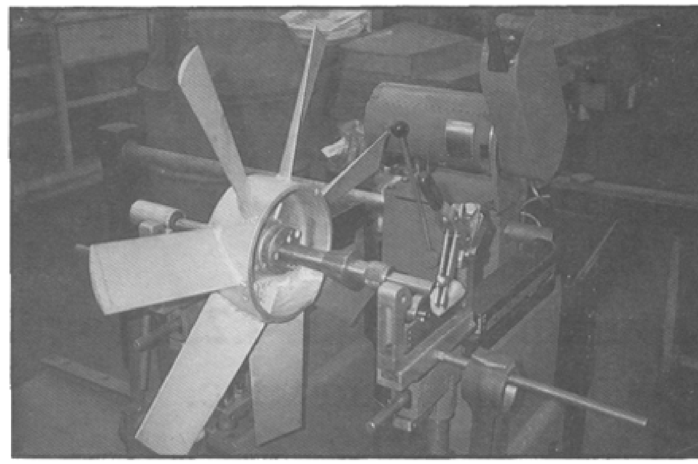
Lets look at some of the charts, since a picture is worth a thousand words. Keep in mind that we are targeting non-automotive work with these slides. Also, these jobs required only off the shelf equipment. It is important to know that special tooling is seldom needed.



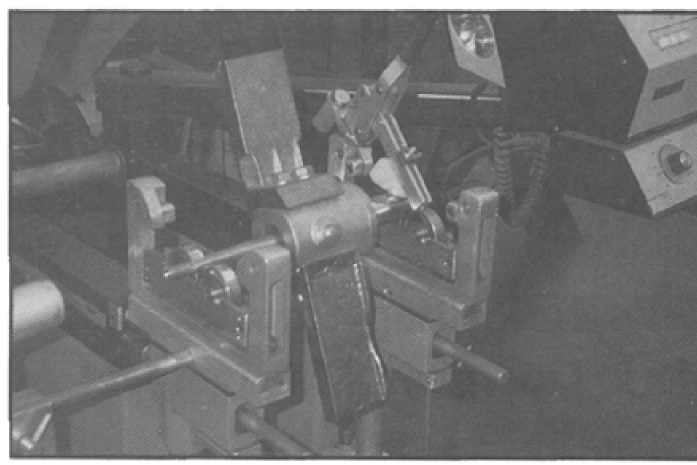
1. Our first slide is of a shaping disc, approximately $2^1/_2$ feet in diameter. It is used in the wood products industry. The time taken to complete the job is 35 minutes.



2. Slide two, is a heavy duty flywheel. Self explanatory for applications, time 30 minutes.



3. Number three is an air duct fan with a balance time of 40 minutes.



4. Next we have an impeller that throws steel shot. The steel shot or balls wear away the front or leading side of the impeller. Rather than throw it away, the fix is to turn the impeller 180 degrees on the hub. But guess what, it then needs balancing. Total balancing time is 15 minutes per unit.

As you can see, from our next slide the job was to balance 10 units. This job would return at the rate of about $9^1/_2$ times normal hourly rate.

What you're seeing there is basic as what we showed today is if that changes .001 amount of an inch, its times the bob weight, you might have an 1800 gram bob weight. What we're seeing when you're changing the bob weight, even if we're measuring it absolutely exactly in between the two splits. It is just reading the change. It is reading the change of mass when it is going on the journal, most bob weights are made out of aluminum, the v's are cut very nice. When putting your bob weights on, to make it easier put them all to the center, all to the left or all to the right.

Following up what he was talking about bob weights, most manufacturers have manufactured two kinds, lead shot and stackable weights and one of the biggest comments we get about lead shot, because you're dealing with such small increments and you can be that much more precise, but what he was talking about is that you've got a cylinder wall and you got the lead shot in it and some of the common things that happens is repeatability balancing machines, people go immediately to the head, whether it's an analog or digital and they start there with their problem or often times they will go through and check these bob weights through the repeatability of spinning, those things will loosen up and as that lead shot falls to one side or the other, you just affected your mass. They need to be tight.

Q. We hear about the differences percentage wise in V8 and V6 balancing. Could you explain that?

A. The bob weight percentages are determined by the OEM manufacturer when they design the engine and the running mass. What comes into play is having to chart the percentages and then some of the pieces that effect the balance the job, and that would be motor mounts and the condition of them. The percentage on most automotive is 50%, the V6 is 45-46%. We are going to help AERA get with the manufacturers to make sure on stock engines with stock mounts that we get the proper percentage. The earlier engines is 40% reciprocating and 100% rotating and the balance shaft motor that we are going to see more of is just like a V8, 50% reciprocating, 100% rotating. I think it is vital for the shop that you have to ask the customer and make sure what engine you're dealing with. If anybody has looked at a new car, you have seen these engine mounts, and all V6's shake. They will always shake and it is very vital to use the stock mount with the stock engine and there is a lot of change going on. You have to make sure that on a V6 engine that you're customer is using the proper mount for the proper year.

A common term that we have used in tolerances of .5 and .2 we hear it all time, seems that a lot people always chase those standards, but when we are working the diesel or industrial, it seems to be a redundant problem. We see people trying to take a Detroit 671 or Mack and take it to 2/10ths ounce inch.

Q. Would you elaborate?

A. They are entertaining themselves if they take an engine that size down to .5 or .2 it goes back to the same formula and that's why it is so important to get used to using that, that engine is going to turn maybe 17, 18, 2,000 rpms in all and it has a much heavier crank than the automotive. The balance tolerance is a full 1 or 1 1/2 instead of .5 per plane, so total allowable 2 ounce inches.

I fooled around with moving the bob weights around back and forth on the journals and I've noticed a lot of change and if you don't have your bob weights dead center on the journals, you will get different readings.

Q. But you mentioned that if you put all your bob weights to front, back or center them up that is the most important. But on a V8 because it works on a couple. If you have all the bob weights to the front isn't that going to change the relationship between the bob weight and the counterweight that is counter balancing it because you're spacing them more to the front or back?

A. No, not at all. It is actually personal choice, you want to be consistent when putting them on. I think the important part is that they are all the same. Make a chart up of each engine and readings.

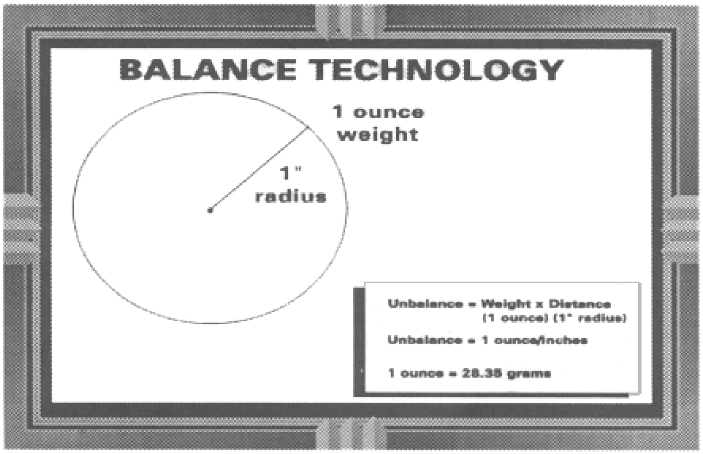
On that chart you can also record what the previous bob weights readings were and what made up the bob weight. Sometimes if you start to rotate the crankshaft and your numbers seem out of line, it is really good to have ready reference.

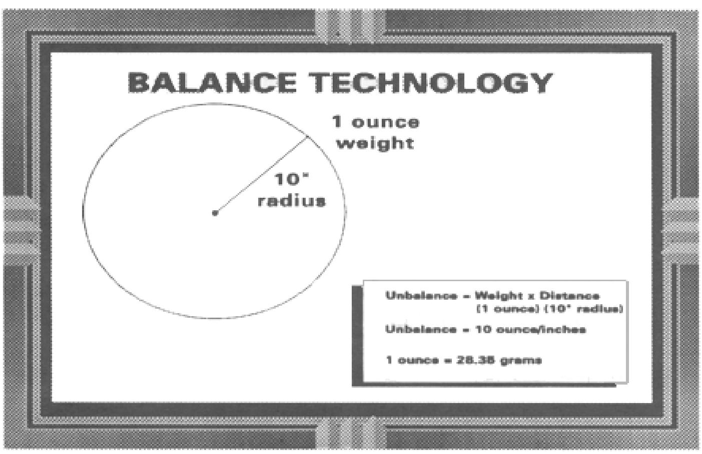
Q. I've been told that on high-performance application that you want to increase your reciprocating weight as the rpm goes up, is that true?

A. No, that is not really true. A regular V8 is going to be 50% reciprocating, 100% rotating. We haven't really talked about overbalance, but everyone knows about it and what they are doing basically instead of a regular V8, because we have 90 degree block, they are adding 1-3% to their reciprocating total.

I am going to finish on one little funny note, we talked a little this morning, everybody is worried about tolerances and doing a good job, I had a client call up and he said, "Gary, you've got to help me, I've been building this race engine, its a 4 wheel drive truck puller and it was a 468 cubic inch big block Chevrolet on alcohol with a huffer injected and he was on the national circuit. The crankshaft cost was 4,000 dollars and he said, Gary, my machine is wrong, checked my bobweight, I lost everything, I broke 4 cranks. So after studying everything, his totals were right, how's the machine, how's the tolerance, how hard is he turning the engine, 9,200, I said, this guy is crazy, what do you mean 9,200? The customer said it only has to last 30 seconds!

We appreciate being here. Thank you very much!





On the bottom of the slide is an example of this formula being used on a stock 350 Chevrolet V8, 70lb crankshaft that runs at 5,000 rpm, so we have the tolerance in ounce inches is equal to 2.4 times the 70lbs times 16 ounces divided by the rpm which is 5,000. The exact answer is .5376 ounce inches or equivalent to .5 ounce inches total tolerance. If we are doing a two plane job, we just divide by 2, depending on what kind of machine you have. We do know by experience that usually stock engines are balanced down to .5 ounce inches per plane and that racing engines should be .2 or .3 ounce inches per plane. We can always go back to the above formula and prove our tolerances.

On our next subject, what about the shop you're competing with a mile away. He claims that he zero balances all his work and he has the latest high tech machine, is that possible, zero balance? I just want to say that we always have unbalance left, .01 ounce inch, .001 ounce inch, .0001 ounce inch. What we want to do is quality work as stated before. Figure out the weight of the part, the speed it runs and bring it down to the proper tolerance.

Last I just want to briefly touch on how to check your machine to see if the calibration is correct. This is not a standard calibration arbor, it's just something that most automotive shops can do to check their machinery. We can take this next slide showing a standard automotive flywheel. On a flywheel arbor this will give us a good indication of what the machine should be reading, (before you mount your flywheel arbor be sure the tooling is down to a low tooling tolerance), about .1 ounce inch or lower and as I've shown on the slide follow the dimensions and add the normal weight. I really think this is very important, we all get very busy, maybe 2-3 men running the shop or just yourself and it's just a real good thing from time to time to either have the shop foreman or owner take the time to check the machine especially if it is being used a lot, It is just a good procedure to set some time aside, even once a month take a look at your machine and make sure that everything is in good working order.

John Bianchi, do you want to finish now?

I think many of you have seen this example before. This is done with a 1/4 of a ounce or 7 grams at 4 inches from center, about the same size as a counterweight on a Chevrolet crank. At 2,000 rpms, 7lbs trying to get out of that engine, trying to get away from that crankshaft, 4,000, labs and it goes up from there. Most of us know that we are not going to turn that automotive engine 8,000 rpms for practical purposes but, it is a great example because on the industrial side you are going to run into items that are going to run 18-20,000 rpms, and the same rules apply depending on the weight and the rpm.

I think one of the greatest services that we could provide to the membership is understanding how to achieve tolerance. So often a customer will bring a rotor into one of our shops and we will accept it and balance it and we will maybe take it to .5 or .2 1/2 thinking we are doing the right job. Often the job is correct and will run well, but how much time did we waste in the meantime. If we had taken the weight and the rpm and use the formula that Gary showed us and is available on the handouts when you leave, maybe that only needed to come down to .8 or .9 and the rest of the time you're just entertaining yourself and you are not giving your customer back anything better than the original .8 would have given him. Maybe we could entertain some questions and go along that line.

Questions

Q. One of the most common questions I get is when I take off my crankshaft and remove the bob weights and put it back on, and they don't repeat exactly on your machine?

A. You finish the job, you take it off your machine and you rotate your bob weights to 180 degrees and what we are showing is just so important is that everybody would love to have beautiful perfect tooling, I have seen from racing, take Mazda, they may spend $50 dollars on a set of bob weights and they are so precise you could do that. All the manufacturers that make bob weights, make them as best as possible within the confines of the cost.

Actuals for a 2 to 3 Man Shop

Year	Months	Yearly Volume	Accum. Volume
1	Aug - Dec	$931.40	
2	Jan - Dec	$3,134.55	$4,065.95
3	Jan - Dec	$5,146.10	$9,212.05
4	Jan - Dec	$5,775.00	$14,987.05
5	Jan - Dec	$8,182.50	$23,169.55
6	Jan - Dec	$8,620.00	$31,789.55
7	Jan - Dec	$13,588.75	$45,378.30

Take a minute and study this graphic. As you can see, the machine was purchased in August of 1979, and produced $931 dollars of labor in those five months. The center column is the dollar amounts per year, and the right hand column is the running total of the years or accumulated totals. The cost to enter the balancing field is about $5,000 for a used machine to approximately $20,000 for a new state of the art machine. Another first step in entering the field could be to purchase the gram scale. This would allow you to do at least part of the job before you send the crank out for the remainder of the work. At this point, we are going to get into a little more of the technical side. Are there any questions before we proceed?

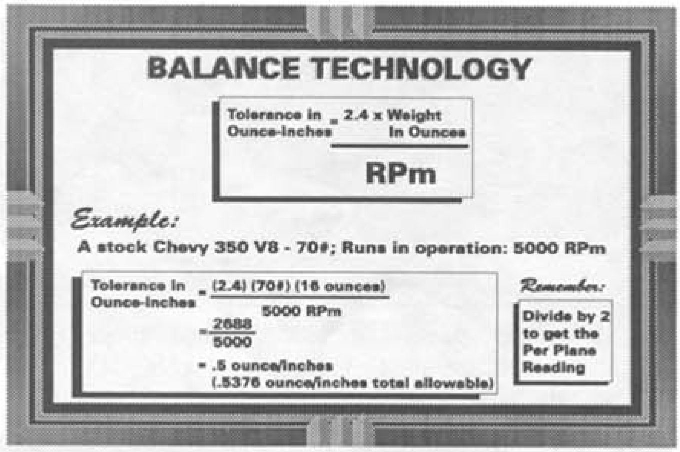
Now, let me turn it over to Gary Hildreth, thank you.

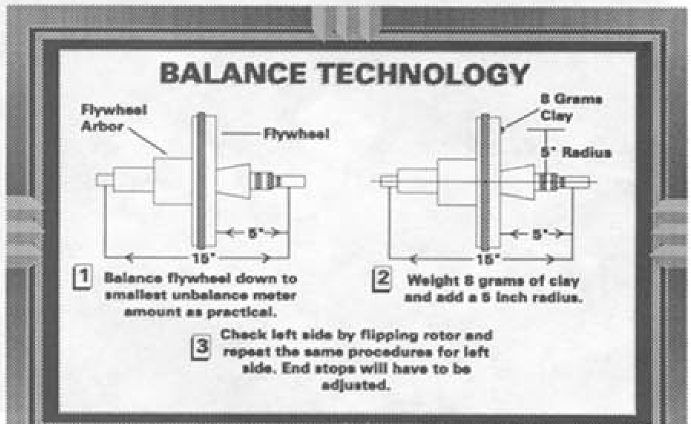
Good morning, I'd like to start off today with, "What do balancing machines read?" What is that magic reading. I will be giving you quite a bit of technical information. All of this information will be available for you to take home and review after our presentation.

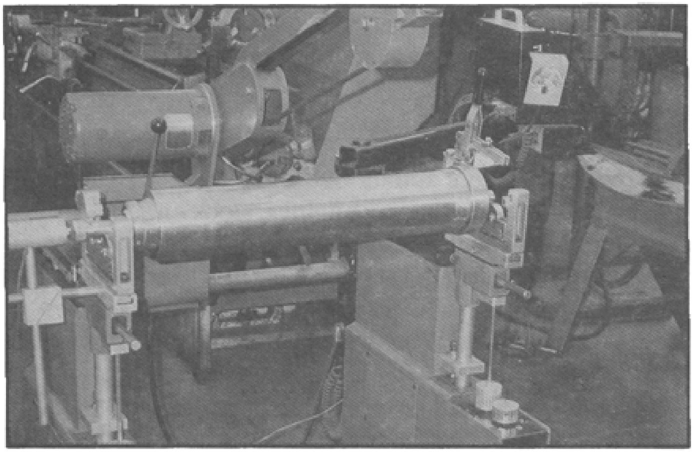
What is unbalance? What are all those different tolerances for? Let's take unbalance first. Unbalance is equal to weight times distance, the distance being the radius of rotating mass from the center line and the weight being the ounces or grams. A simple example shown on the first slide shows a 1 ounce weight at a 1 inch radius, what is that equal to? Some kind of balancing magic... no, it is weight times distance. So, a 1 inch radius times a 1 ounce weight is equal to 1 ounce inch. In our next slide you will see the same 1 ounce weight but at a 10 inch radius. The same rules apply, this simple little formula on balance is equal to weight times distance, so that's a 10 inch radius times a 1 ounce weight is 10 ounce inches. You will see listed on the slide that a 1 ounce weight is equivalent to 28.35 grams. Anytime we want to convert to gram inches, we just multiply 28.35 times the ounce inch reading.

Now, my assistant here Mr. Bianchi will show us a simple demonstration of what a crankshaft feels. What we are trying to demonstrate is the very basics of what the crankshaft is going to feel or does feel from the center line as the force tries to get out. All we've done is taken the strain and put a weight on it and if I come out here to about 3-4 inches and rotate it, there's not much moving in my hand, weight times distance. If I move the weight out about a foot and do the same thing, it takes more weight and it's that force that the crankshaft is feeling as part of it rotates, just a real simple basic example.

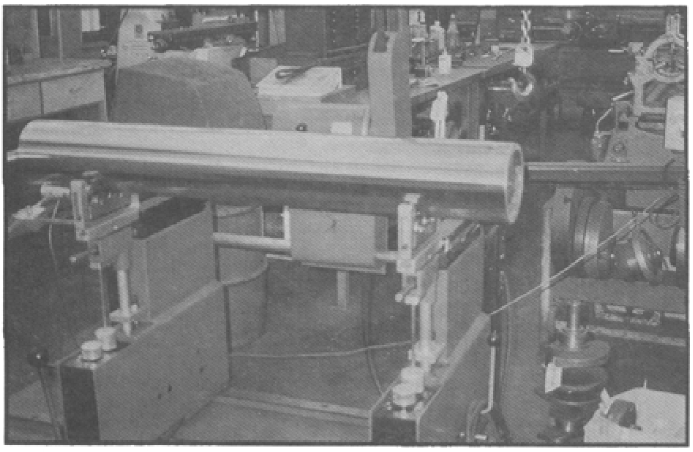
How do we figure automotive and industrial tolerances, tolerances for racing engines, stock engines, armatures, flywheels, turbans, fans. Shown on the next slide we have a very good basic formula, tolerance in ounce inches is equal to 2.4 times the weight in ounces divided by the rpm. What we all need to know is how heavy is the part and what is it going to run in operation. The rotating part will never realize the extra work, because we have determined the proper tolerance, especially on a non-automotive job and that is what we're keying on, it is very vital that we determine both of these simple items. If a customer comes in with a fan armature or any non-automotive item, you can be prepared to figure up their tolerances and tell them what the tolerances should be.



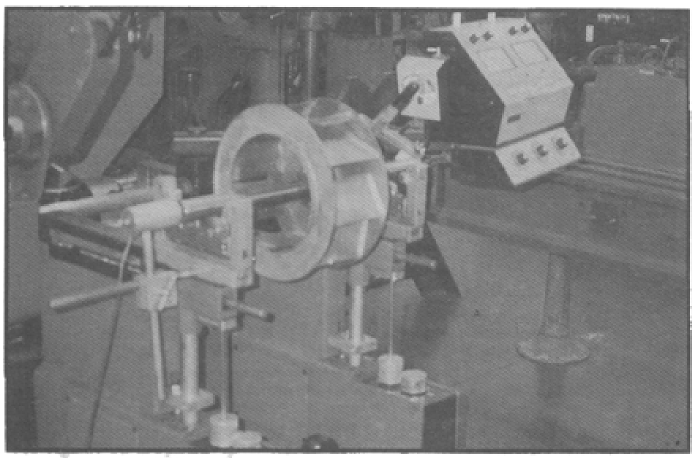




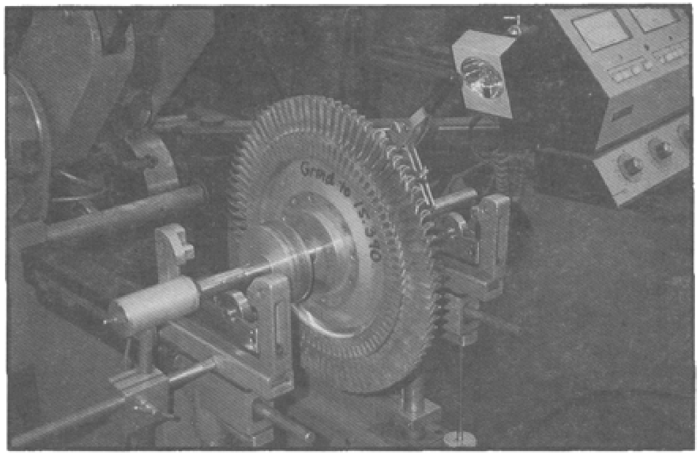
5. Our fifth slide is of a centrifuge bowl. This is used as an oil separator in a marine application. Balance time is approximately 45 minutes.



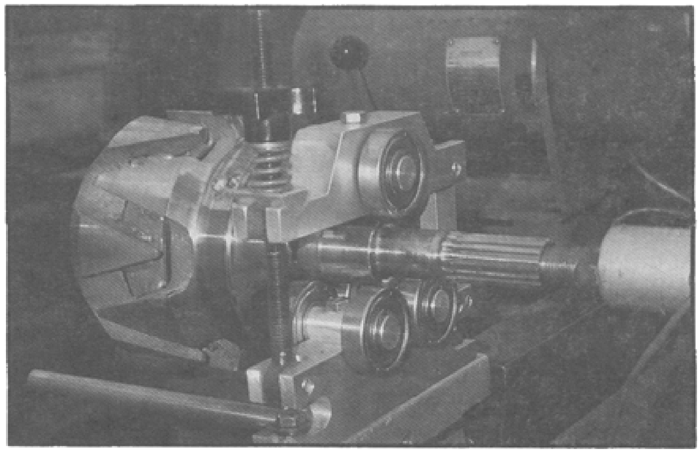
6. Slide six is a press roller used in the newspaper business. It is almost 5 feet long, weighing 300 pounds. Time is 1 hour.



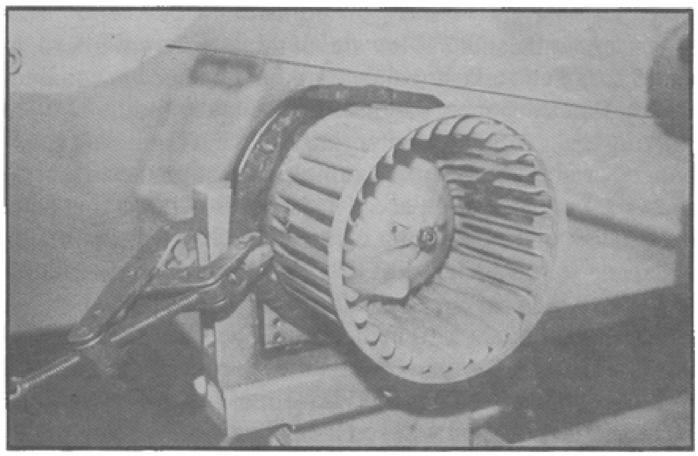
7. Our last example is a plain old blower fan. We usually do these in groups of 10-15, time per fan is approximately 15 minutes.



8. This is a compressor wheel followed by a compressor section from the same engine. These are Vietnam era helicopter engines, now used in other applications, specifically hydroplane racing.



9. Oil drive alternator, balance time is 20 minutes, rate is 2 times the shop rate, balance on 1 column.



10. The last slide is a small blower fan from an automobile.

The focus on all these jobs is service, quality, versatility, then price. Before I turn this over to Gary, I would like to share with you some dollar amounts generated on my machine. These figures are for the years 1979 through 1985. I know these to be accurate, as I kept the records myself. The shop was a two to three man operation.