Joe

208-661-6797

OPERATING INSTRUCTIONS

HC-500-2PL

HARD BEARING BALANCING MACHINE

1986

Chris McFarlen - Direct → 6627

734- 769 - 2300

II 4

Service

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ILLUSTRATIONS

INSTALLATION

Correct installation of this machine is crucial to the success of balancing operations. Because the balancer contains sensitive equipment, incorrect installation or an inappropiate operation site will cause the machine to malfunction.

SITE SELECTION

The Hines Balancing machine is shipped on a skid in a cardboard enclosure, with smaller components packed inside the crate. Do not remove the machine from its skid until you have chosen an installation site and moved the machine there. The machine does not require a special foundation, but it must be mounted on a smooth concrete floor. If a wood block floor is used, remove the wood blocks and mount the machine directly on the concrete. The floor should be free of large cracks or divisions directly below or surrounding the balancer. Do not place the machine on a site affected by large floor shocks, like those caused by punch presses and shearing machines. Nothing should be placed between the leveling screws and the concrete.

UNCRATING

As you uncrate the equipment, check it against the packing list to determine if anything has been lost or omitted. Carefully examine the components for damage which may have occured during shipment, and report any to the transporter immediately. Under normal conditions, the machine is shipped ready for use, except for unpacking, mounting to the floor, and attaching the cables and electrical connections.

LEVELING

After the machine has been placed in its final location, use the four leveling screws packed with the accessories to level the machine. If you need to move the machine slightly after removing it from the skid, use a piece of wood on the end of the machine slightly after removing it from the skid, use a piece of wood on the end of the machine under the protrusion and lift the machine with a jack as a lever. Do not use a metal ply bar, it will only chip the concrete base.

Insert the four screws into the corner holes in the under side of the base. The leveling bolt at the highest corner of the machine should be left run in all the way, and the others should be used to level the machine. Use three of the screws to level the machine, but do not run out the screws more than 1 1/2 - 2 inches, or the machine will resonate.

Using a carpenter's level, check the level of the machine: side to side and front to back, accurate to 1/16 inch. Be sure the weight is evenly distributed on the four screws, so the machine cannot rock on two feet. Bring the fourth screw down firmly on the floor and tighten the locknut against the bottom of the machine, then tighten the other three locknuts. Once installed, the heads of these screws should directly contact the concrete. Hit the side of the machine with your fist to be sure it is setting firmly and will not resonate.

GROUTING

For long term reliability and especially when attempting to achieve fine tolerances on large parts, we recommend that the machine be grouted to the floor. Use non-metallic machinery grout.

Make several 4" cardboard forms the height the machine is off the floor. Level the machine. Lift it off the floor and position the forms approximately 6" apart around the perimiter of the base. Lower the machine onto the grout. Inspect it to see that the grout is in contact with the base. Do not distrupt the machine for at least 8 hours after the grout has been applied.

Note: If you elect not to grout the machine, check the leveling nuts occassionally. They tend to loosen as the machine settles onto the concrete.

MECHANICAL ASSEMBLY

Remove the various components from the packing. Remove any protective grease from exposed surfaces and replace with a film of oil.

To attach the amplifier, take it out of the box and remove the 1/4-20 x 3/4 hexhead screws from the underside of the base. Set the amplifier on the amplifier bracket, then insert and tighten the screws. Connect the 3 cables to the proper amphenol connectors on the rear of the analyzer. (Figure 1)

ELECTRICAL CONNECTIONS

Electrical connections are made at the back panel of the analyzer. These include:

- AC power cord 110 Volt
- PPR pulse sensor (amphenol)
- Unbalance pick-ups 2 (amphenol)
- Fuse 1.5 Amp
- Calibration adjusts. 2-amount & angle

Amplifier	:	110 VAC/1ph/60Hz
Fuse	:	1 amp
Motor control	:	180-250 VAC. Over 250, a step down transformer must be used. 180-200 VAC: modifications can be made to the controller. See Lovejoy manual. 1hp: 220 VAC/1ph/60Hz 2hp: 220 VAC/3ph/60Hz
Rotation	:	Clockwise- facing angle indicator disc
Drill Presses	:	
20"	:	220VAC/3 ph/60 Hz
16 1/2"	:	220VAC/1 ph/60 Hz

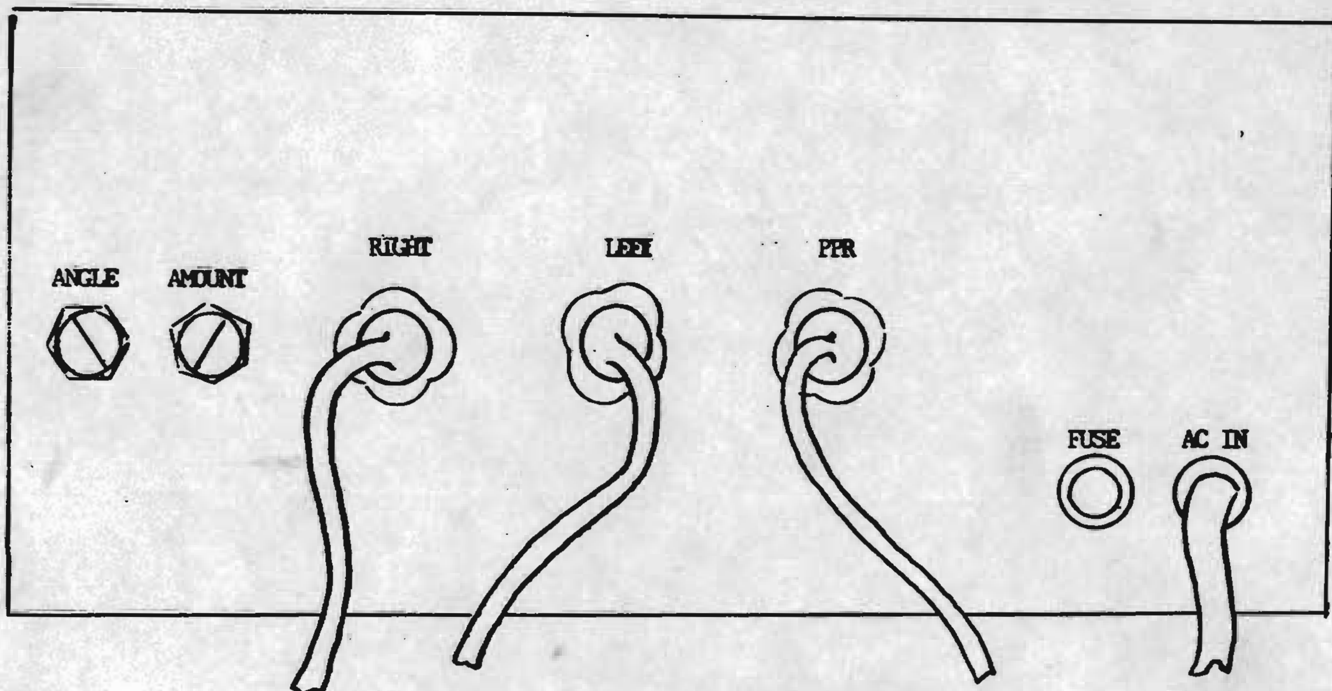


Figure 1 Analyzer back panel

DRILL PRESS

Optional Equipment

Drill Correction System

The drill press is positioned so that it is centered directly over the correction point and locks into that position when drilling is intiated.

Minor adjustments may be made as follows:

1) Center the drill press by moving it forward or backward on the mount.

2) If the drill press tilts back too far before locking, tighten the cam roll sleeve, and/or adjust the block on the rear of the mount.

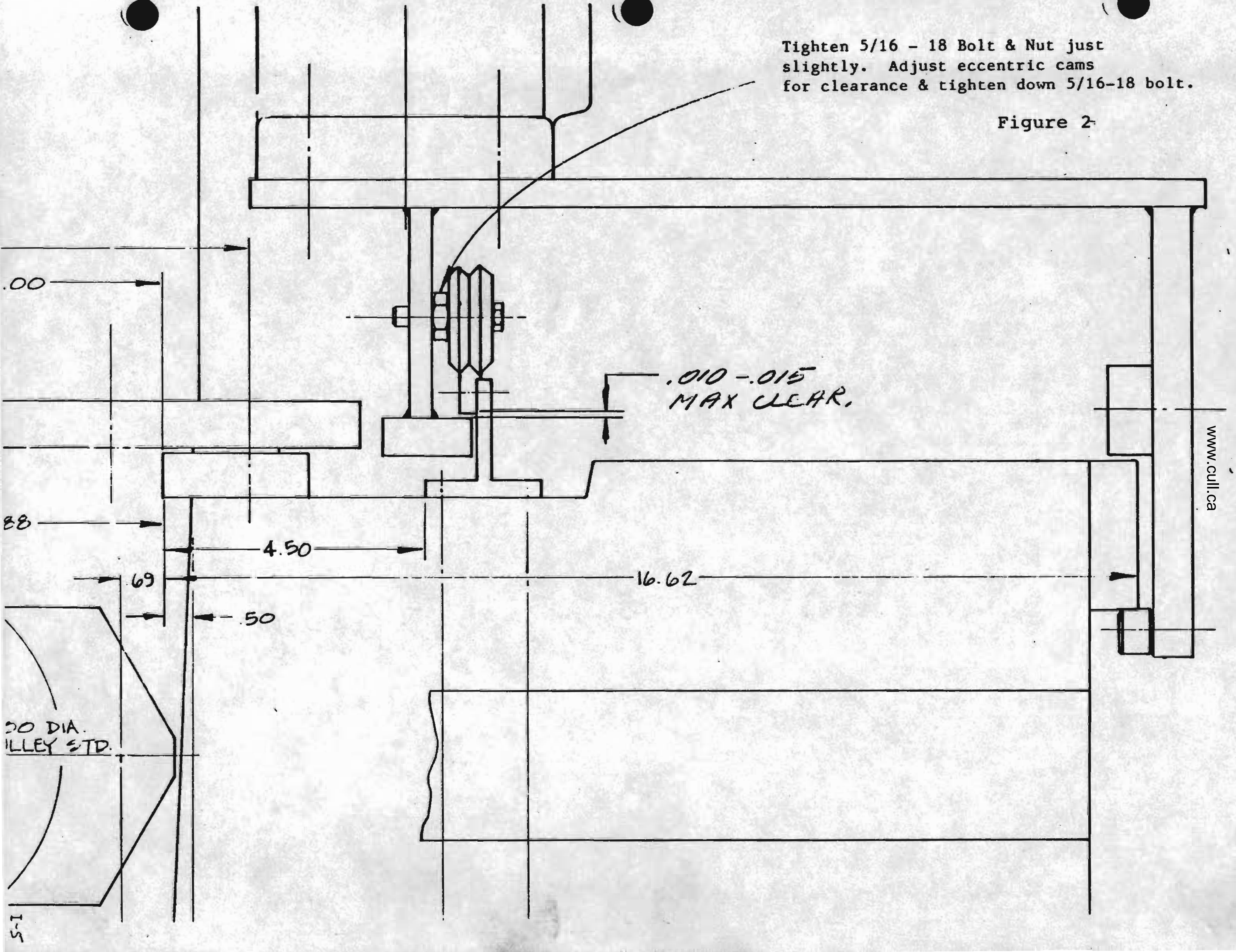

Tighten 5/16 - 18 Bolt & Nut just slightly. Adjust eccentric cams for clearance & tighten down 5/16-18 bolt.
.010 -.015 MAX CLEAR.
.00
88
4.50
.69
16.62
.50
DIA.
LLEY STD.

Figure 2

Digital Scale

General Description:

The Model 3115 Industrial Scale is an electronic light capacity scale. An independent self-contained electronic box scale which provides a visual digital readout for the operator with 100% tare capability.

Weight display is via four digits of 7 segment LED's and a keyboard providing pushbutton zero and tare.

Specifications:

A. Electrical & Physical

1. Physical Construction
   Die cast aluminum base, Cover and platform are molded plastic. Platform 9" x 12". Overall 16" L x 13" W x 7" H. Weight: 16lb.

2. Power Requirements
   120VAC ± 10%, 60 Hz; single phase; 0.25 amperes.

3. Capacity
   9.990 lb x .002 lb/5 kg x .001 kg.

4. Digital Display
   Four digits and minus sign, seven segment LED's - 0.55 inches high.

5. Lighted Legends
   Lighted spots adjacent to printed legend are KG, Net, and Tare.

6. Level Indicator
   A spirit level incorporated in the platofrm provides a level reference.

B. Internal Functions and Interlocks

1. Display Messages or Signals

   a. Weight greater than 5 increments over capacity blanks weight display.

   b. Under zero display reads true negative numbers with minus sign.

   c. Display blinks on power up until the scale is zeroed.

   d. Alternate action of the CLEAR button displays all segments and legends on or all off.

2. Motion Detection

Zero and tare functions are inhibited whenevr motion is detected. An optional program switch selection may also hold the displayed weight until the motion stops. (SW1-2)

3. Automoatic Zero Maintenance

Weight variations within ± Ø.2 increments per second are compensated to zero. Compensation range is ± 2% of capacity from true zero (as calibrated) or a total of 4% of capacity. May be disabled by internal program switch. (SW1-3)

4. Pushbutton Zero

When the weight displayed is within the zero correction range and no motion is present, pressing the zero pushbutton for two seconds will cause the weight display to be zero.

The range of this correction is ± Ø.2 lb for 9.99Ø x .ØØ2 lb. and ± Ø.1 kg for 5 x .ØØ1 kg.

5. Tare

Platform tare may be used at any time unless tare interlock is selected. (SW1-4)

C. External Controls

1. Display Switch

The display switch is located under the scale on the right side near the fuseholder. This switch is on a signal line to the microprocessor which is held at 5 VDC by a pull-up resistor when the switch is open. In this open position the display is ON. Closing the display switch brings the signal to ground and the display is then turned OFF.

CAUTION: When the line cord is plugged into a power source, the line voltage is present and the scale is on. To service the unit, unplug the line cord and observe safety precautions.

2. Keyboard

The keys used will be zero and tare. The other keys are not required for balancing rods and pistons.

3. Normal Expand Switch

Scale is set to read KG (NOR) and tenths of grams (EXP.) 1Ø lb. is equivalent to 4.5359 kg. Expanded by ten equals 45.359. With the 4 off the display, therefore, you will read 5.359 in expanded mode.

Installation Instructions

1. Install the platter making sure the gap between the platter and front of scale is even.

2. Back off the red screw on the bottom of the scale. CAUTION: This screw must be retightened if the scale is shiped. DO NOT OVERTIGHTEN. THIS WILL DAMAGE THE SCALE.

3. Level the scale and tighten leveling nuts.

4. Apply power.

5. Depress and hold the zero key for two seconds to stop the blinking.

Installation Instructions - Rod Weighing Device

1. Position the scale and rod weighing device so that they are square with each other as shown in Figures 3 and 4.

2. Fasten the pan adaptor to the scale. Select and mount the appropriate rod adaptor. Press tare.

3. Adjust the slide bar so the arm hangs vertically with a rod in place.

Note: All bearings should spin freely. Each adaptor should spin freely on the bearings.

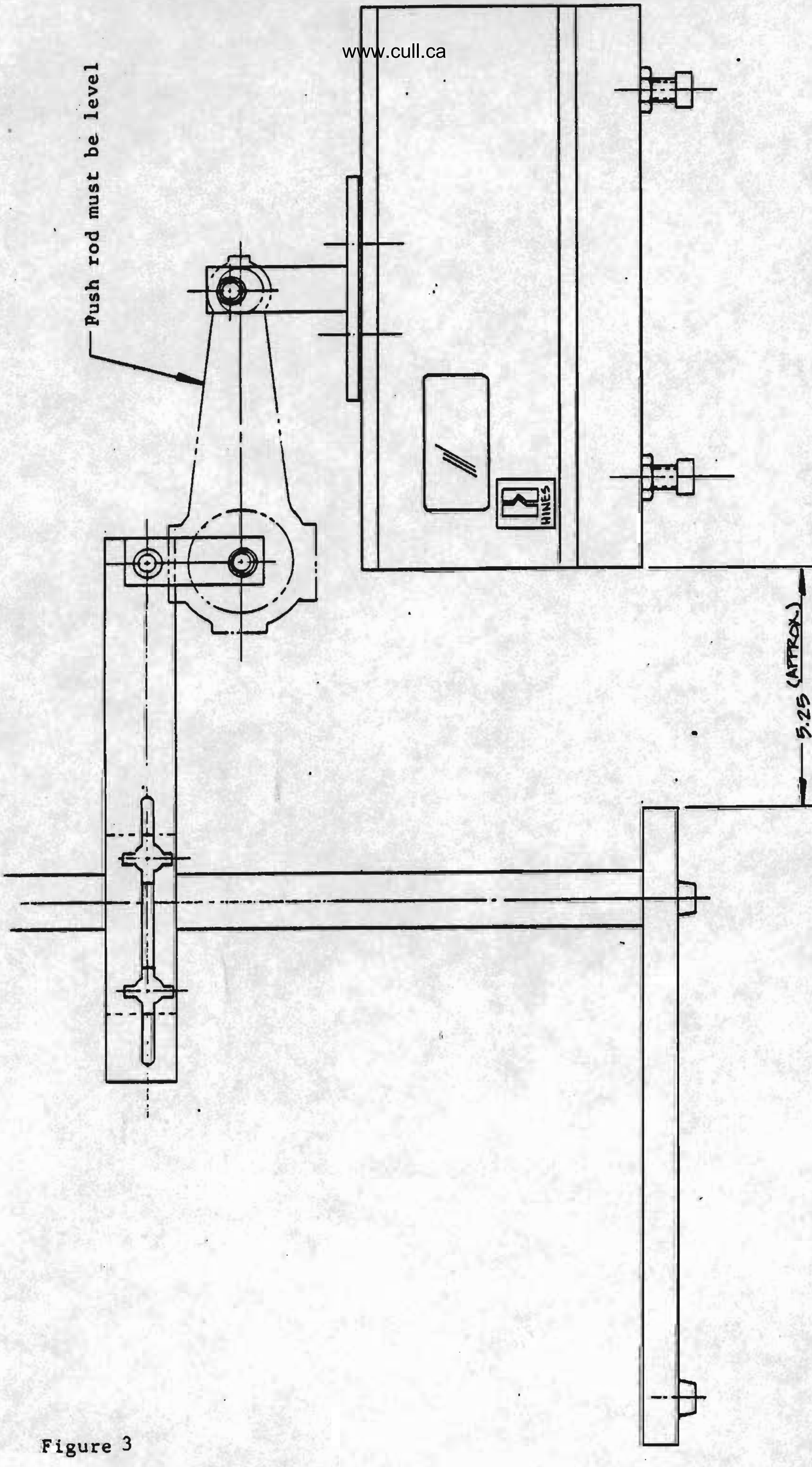


Figure 3

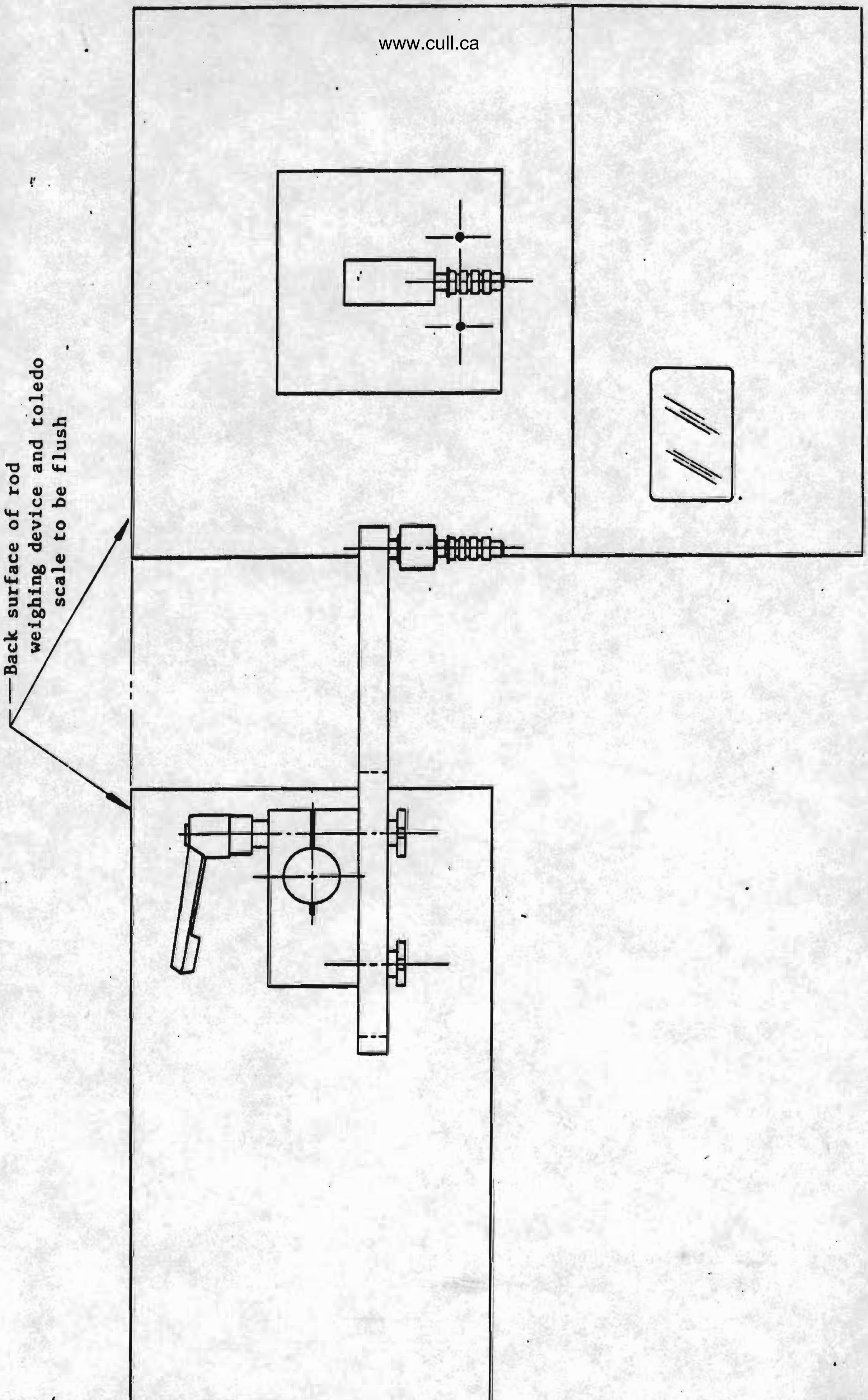

Back surface of rod weighing device and toledo scale to be flush

Figure 4

SECTION II

MACHINE COMPONENTS AND THEIR FUNCTIONS

ELECTRONIC UNBALANCE MEASURING SYSTEM

AMPLIFIER- The unbalance pickups and the pulse sensor detect the unbalance in a workpiece, which the amplifier processes to display the correction angle and amount. The operator sets the controls according to the specific parameters of each workpiece.

FRONT PANEL: See Figure 5

All operational controls are at the front panel. The bottom row of buttons control the electro/mechanical functions of the drive system. These include:

SPEED SLOWER/FASTER: Adjust RPM balancing speed

SPIN: ON- starts drive motor
- starts analyzer measure cycle
OFF- stops/brakes drive motor

MOTOR: Enables power from motor controller to drive motor

INDICATOR LIGHTS:
POWER- indicates supply voltage to motor controller
MOTOR- indicates power supply to drive motor
TRIP - indicates overload fault at motor controller
Remove power supply to reset

Two lines of display prompting are located at the center of the analyzer front panel. The power ON/OFF is to the left of the display. The ALPHANUMERIC and MODE/FUNCTION keypads are located to the right of the display.

USE OF THE MODE/FUNCTION AND ALPHANUMERIC KEYPADS

All the necessary parameters for balancing are contained within a program and are easily modified as necessary by means of the keypad.

In SETUP mode the parameters are sequentially displayed. After a parameter is altered or examined by the operator, the next parameter is brought to the screen until all SET UP parameters have been accessed. This default sequencing ensures a complete SET UP by prompting the operator, deters accidental parameter changes and takes less time.

The Mode Keys Include:

SET-UP -Readies the balancer for use
2 PLANE -Correction dimensions are programmable in SET UP
LEFT RIGHT -Correction dimension preset for CRANKSHAFTS
FORCE -Single plane balancing such as FLYWHEELS
UNBALANCE -Correction dimensions are preset. Unbalance units at 1 INCH or 1 CM RADIUS ONLY.

The Function Keys Include:

ENTER -To change a parameter in SETUP mode
NEXT LINE -Skip or no change, move to mext parameter
BACK SPACE -To select modes. To exit SET UP at any time. To back space and correct numeral entries.

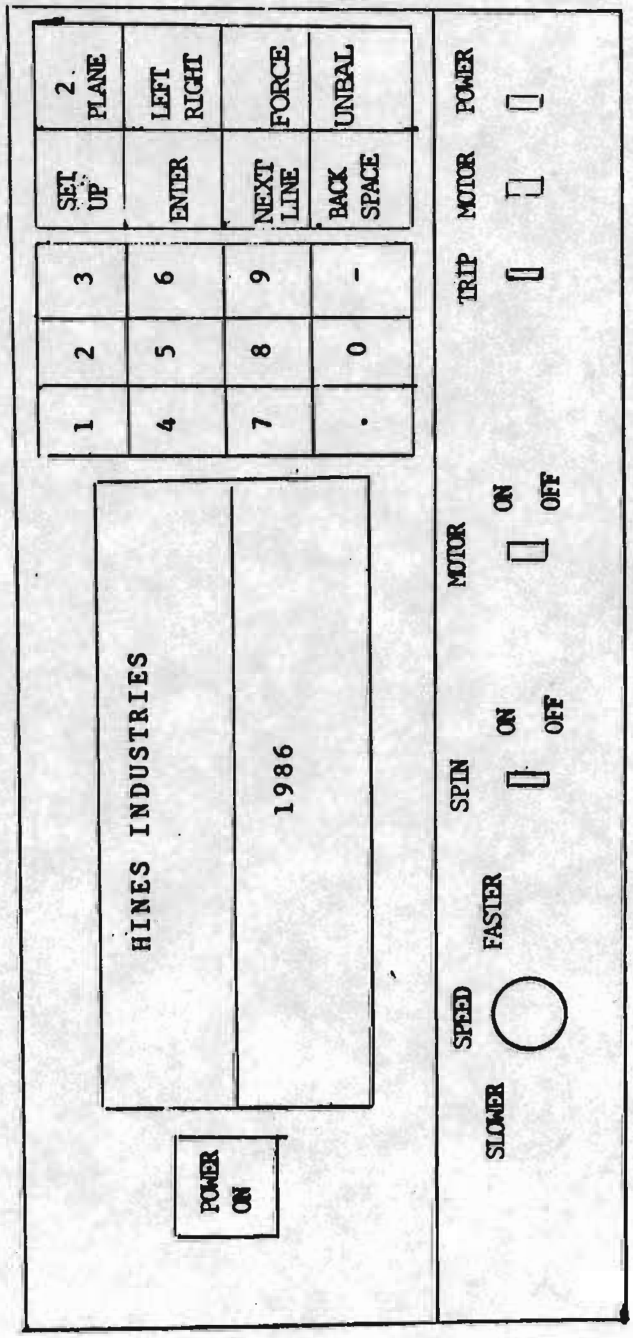


Figure 5. Analyzer front panel

DESCRIPTION OF BALANCING PARAMETERS

RPM — Speed of workpiece rotation (crankshafts and flywheels 500 RPM). In SET UP used to adjust speed.

IN/CM — Inches or centimeters. To specify English or metric units for the correction RADIUS and DIMENSION distances of the workpiece. These numbers will be entered further on in SET UP. The units are chosen here.

OZ/GM — Ounces or grams. To specify the English or metric units for the correction amount. The UNITS are chosen here.

UNBALANCE UNITS — OZ/IN Ounce Inches
GM/IN Gram Inches
GM/CM Gram Centimeters

To specify the units in which the unbalance TOLERANCE of the workpiece will be programmed in the parameters. TOLERANCE is the allowable unbalance in a balanced workpiece. Tolerance units will be specified amount measured only at one (1) inch or one (1) cm radius. One radius unit is used in accordance with ISO standards and conventions and most OEMs. Since the unit (eg. OZ/IN) is a weight X a distance, with the distance at one (inch), the weight reading is isolated and unaffected by correction radius which may vary.

The TOLERANCE setting will not effect unbalance measurements or display. The AMOUNT of tolerance will be entered further on in SET UP. The units are chosen here.

RADIUS — The distance from the workpiece center to the point of correction. An Accurate measurement of this distance is required to achieve optimal calculation of amount needed to correct unbalance. Since the workpiece may not have the same correction radius on the left side as on the right, separate left and right radius settings are provided. The appear as:

LEFT RAD.	3.5
RIGHT RAD.	7.0

The numbers will be in the units (inches or centimeters) chosen in the IN/CM set up parameter above.

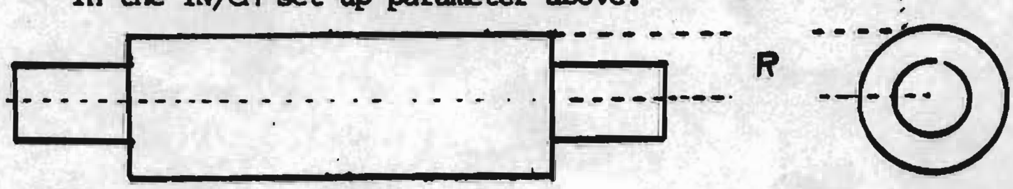


Figure 5a Radius Measurements

TOLERANCE Specifies the allowable unbalance tolerance of the workpiece. For example, if the unbalance tolerance is 1 OZ/IN, and the workpiece unbalance is .50 OZ/IN there is no need for further correction on piece. Once TOLERANCE is reached, "OK" will flash on the display when the part is spun on the balancer.

Balancing workpieces to specified tolerances is time efficient and practical. Balancing everything to "zero" is overkill and becomes increasingly difficult with heavier workpieces.
Left and right tolerances are provided:

LEFT TOL.	12.34
RIGHT TOL.	56.78

ADD/REMOVE Specifies method of workpiece correction; adding weight material such as heavy metal, welding weights, clips etc, or removing weight by drilling or grinding.

When REMOVE is chosen in SET UP, and an unbalance measurement is taken, a minus (-) sign will appear on the amounts to indicate the removal of weight is required at the angle indicated:

- 1.23	-3.45 (amount in SET UP units)
< 60	< 15 (< angle symbol)

When ADD is chosen as the correction method a minus sign will not appear. Notice also that the correction angle is 180 degrees or 30 minutes (0-60 is full circle) opposite in location from the angle in REMOVE:

1.23	3.45
< 30	< 45

LEFT PLANE Specifies the distance from the center of the LEFT bearing V BLOCK to the correction location on the LEFT side of the workpiece. This is illustrated on the analyzer front panel and corresponds to distance L in units from IN/CM. Any correction plane to the LEFT of the LEFT bearing V BLOCK- such as a HARMONIC BALANCER mounted on a crankshaft-MUST BE ENTERED AS A NEGATIVE NUMBER. Use the minus (-) sign on the KEYPAD when entering the amount.

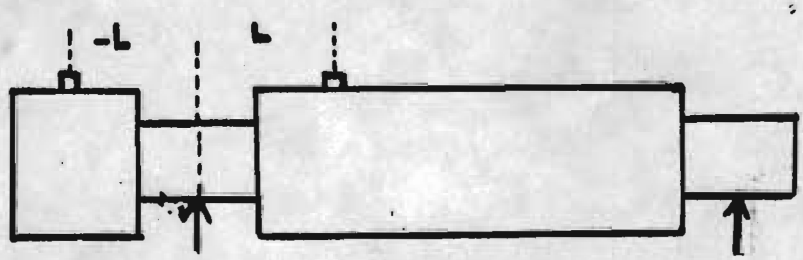


Figure 6-A Left Plane Dimension

RIGHT PLANE Specifies the distance in inches from the center of the LEFT bearing V BLOCK to the correction location on the RIGHT side of the workpiece. This is illustrated on the analyzer front panel and corresponds to distance R in units from OZ/IN.

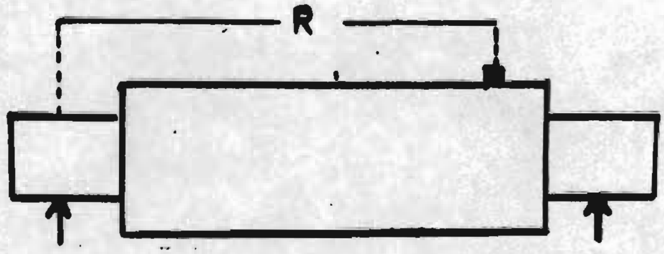


Figure 6b Right Plane Dimension

Notice that both distances are measured from the LEFT bearing V BLOCK. All distances are in units from IN/CM in SET UP.

BEARING TO BEARING Specifies the distance (IN/CM) BETWEEN the LEFT and RIGHT bearing V BLOCKS. Distance B/B on illustration.

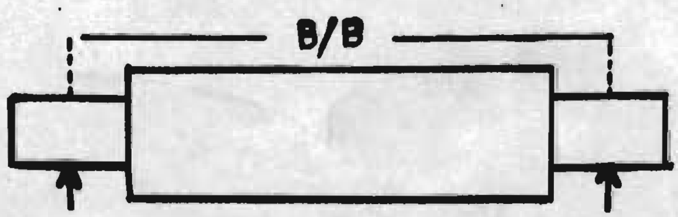


Figure 6c Bearing to Bearing Dimension

BACK PANEL: Figure 1

CALIBRATION CONTROLS
Two calibration controls used to adjust the amount display for accurate amount and angle readout. See the Maintenance section for calibration procedure.

AMPHENOL CONNECTORS
Cable connections for (1) motor control and pulse sensor, (2) right stanchion, and (3) left stanchion.

FUSE
One amp fuse required to operate amplifier.

POWER CORD
Plug into 110VAC/1ph/60Hz power outlet to operate the amplifier.

ANGLE INDICATOR
Located at the end of the restraint magnet in the Pulse/Angle box. It uses a scale of 60 (like a clock), enabling the operator to locate the correction angle on the workpiece.

PULSE SENSOR
Located in the Pulse/Angle box behind the angle indicator. It uses a light sensor and white markers on the back of the angle disc to detect the rpm, and position, in degrees, of the unbalance. The 16 white marks, which form a ring, indicate rpm, and the single white tape inside the ring indicates angle.

UNBALANCE PICKUP
One mounted on each stanchion. This sensor measures the forces on the stanctions generated by the amount of unbalance in a workpiece.

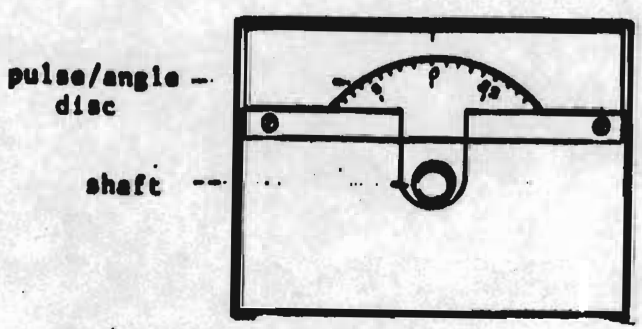


Figure 7 Angle Indicator

WORKPIECE SUPPORT SYSTEM

BASE
Heavy duty concrete and steel provide support of the workpiece and components and reduces outside vibration.

STANCHIONS
Provide horizontal support for the workpiece. They can be moved to accomodate different part lengths, then locked into position with the Kipp handles.

BEARING BLOCKS
Self-aligning, they allow the workpiece to rotate without friction. An oil strap is positioned over the workpiece to maintain a lubricating oil film.

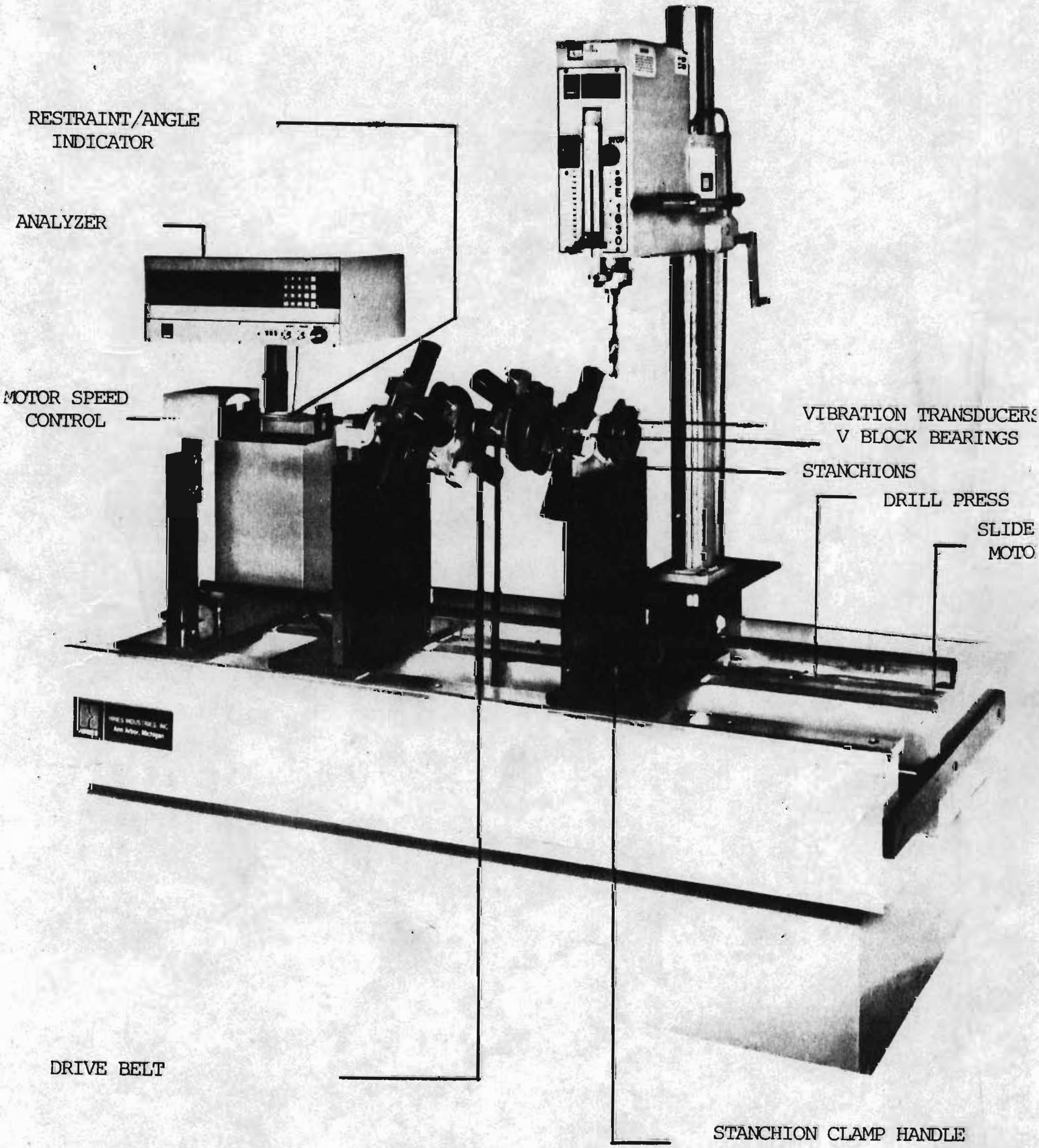
MAGNET RESTRAINT
Attaches to the left side of a workpiece. It prevents end thrust, and holds the part securely in place during balancing.

MOTOR DRIVE ASSEMBLY

MOTOR BELT ASSEMBLY
Drive belt connects the workpiece to the motor pulley. The AC motor mounted in the through drives the workpiece to balancing speed.

MOTOR SUPPORT BRACKET AND SLIDE BAR
Provides support of the motor and enables th operator to position the motor pulley beneath the drive surface of the workpiece.

TOOLING
Provides a precision fit, and enables you to mount the workpiece on the stanchions. Hines tooling is precision machined and balanced to close tolerances to reduce tooling eccentricity and unbalance.


RESTRAINT/ANGLE
INDICATOR
ANALYZER
MOTOR SPEED
CONTROL
VIBRATION TRANSDUCER
V BLOCK BEARINGS
STANCHIONS
DRILL PRESS
SLIDE
MOTO
DRIVE BELT
STANCHION CLAMP HANDLE

SECTION III

OPERATING INSTRUCTIONS

The HC-5ØØ is very simple to operate. Daily calibration is not necessary, but the calibration should be checked periodically, using the procedure explained in the Maintenance section.

POSITIONING AND DRIVING A WORKPIECE ON THE BALANCER

Measure the workpiece Bearing to Bearing distance and adjust the left and right stanchions to this distance.

Place the correct length drive belt over the right stanchion.

Place the workpiece bearing surfaces in the balancer V BLOCKS, which either span or miss any oil holes. If necessary use the grooved 1" bearing blocks which cover the oil holes.

Lubricate the bearing surfaces with a medium weight oil.

Locate a suitable drive belt position on the workpiece and align the drive motor and drive belt, smooth side in.

Adjust the ANGLE DIAL height (thumb screws below) and center the magnet at end of ANGLE DIAL ROD in contact with workpiece shaft end.

START: MOTOR SWITCH ON
SPIN SWITCH ON

STOP: SPIN SWITCH OFF
MOTOR SWITCH OFF when workpiece completely stopped.

ADJUSTING RPM

Press SET UP for RPM

Press Enter on (may hear high pitched whine)

Turn spin switch on motor will now turn

Adjust speed: Faster or Slower

Press ENTER when desired RPM is reached - stops measuring RPM

Turn spin switch Off: brakes motor

Turn Motor switch OFF after motor is fully stopped.
After initial RPM adjustment it should not be necessary to readjust in SET UP MODE unless a different workpiece is driven. Minor adjustments can be made at the beginning of an unbalance measuring cycle. Different diameter workpieces will need RPM adjustment because a different pulley ratio will exist between motor and workpiece.

SETUP PROCEDURE

This is a step-by-step example of the SETUP procedure. It is necessary to complete this procedure and select the correct parameters in order for the balancer to supply the operator with meaningful data during balancing.

The example describes the operator pressing a MODE or FUNCTION key in a "PRESS:" column on the left and follows with the result in a "DISPLAY" column on the right that simulates the actual display given on the analyzer display screen. Additional comments follow in the sequence to further clarify the SETUP operations.

Stepping through the SETUP on the analyzer while reading along here is advisable.

As a general rule, when in SETUP MODE, use the function key ENTER to change a parameter; use NEXT LINE to make no change in a parameter and /or to continue. Use alphanumeric keypad to make changes in numbers i.e. radius, planes, etc.

It is possible to get out of the SETUP mode without accessing all the parameters by pressing the BACK SPACE function key. #-indicates the location of the curser on the display.

A SAMPLE SETUP PROCEDURE:

<u>PRESS:</u>	<u>DISPLAY:</u>
ON	HINES IND. 1986 then SELECT MODE

1. <u>ESTABLISH</u> <u>BALANCING</u> <u>RPM</u>:

PRESS	DISPLAY
SETUP	RPM
ENTER	# Curser will flash, rpm will be displayed

Activate MOTOR switch and SPIN switches with part on balancer and adjust RPM to 500

~~ENTER~~ Enter

2. ENGLISH/METRIC:

IN/CM	#IN (radius will be in inches)
OZ/GM	GM (amount will be in grams)

NEXT LINE to stay in inches, or ENTER to change to centimeters

IN/CM	IN
OZ/GM	#GM

NEXT LINE to stay in grams, or ENTER to change to ounces

IN/CM	IN
OZ/GM	#OZ

UNBALANCE UNITS	
# OZ.-IN.	(Balance tolerance will be in ounces in)

ENTER

GM.-IN

ENTER

GM.-CM

Stop at correct unit for TOLERANCE Specification

NEXT LINE

3. CORRECTION RADIUS:

LEFT RAD	# 0.0
RIGHT RAD	0.0

ENTER to change LEFT RAD

LEFT RAD	# 3.5
RIGHT RAD	0.0

NEXT LINE to hold change

ENTER to change RIGHT RAD

LEFT RAD	3.5
RIGHT RAD	# 3.5

NEXT LINE to hold change

4. BALANCE TOLERANCE: (PART OK flashes on screen when part is balanced to set tol.)

LEFT TOL	# 0.0
RIGHT TOL	0.0

ENTER to change LEFT TOL

LEFT TOL	# 1.0
RIGHT TOL	0.0

NEXT LINE to hold change

ENTER to change RIGHT TOL

```
LEFT TOL          1.Ø
RIGHT TOL       # 1.Ø
```

NEXT LINE to hold change

5. TWO-PLANE BALANCING:

```
LEFT PLANE      # Ø.Ø
RIGHT PLANE       Ø.Ø
```

ENTER to change LEFT PLANE

```
LEFT PLANE      # 1.5
RIGHT PLANE       Ø.Ø
```

NEXT LINE to hold change

ENTER to change RIGHT PLANE

```
LEFT PLANE        1.5
RIGHT PLANE     #17.5
```

NEXT LINE to hold change

```
BEARING TO BEARING
#  Ø.Ø
```

Center To Center

ENTER to change

```
# 19.Ø
```

NEXT LINE to hold change

6. ADD/REMOVE:

```
LEFT ADD/REM          REM
RIGHT ADD/REM         REM
```

ENTER to change

NEXT LINE to continue

```
SELECT MODE
```

****************SET UP IS COMPLETE***READY TO BALANCE**************************

The SETUP parameters are stored in memory. Each time the amp is turned on, it will default to the previous parameters.

MEASURING UNBALANCE

The procedure for measuring unbalance is the same as in DRIVING A WORKPIECE ON THE BALANCER.

With the SET UP parameters entered correctly, and the ANALYZER in the chosen balancing mode: 2 PLANE, LEFT RIGHT, FORCE, or UNBALANCE, measurement will take place automatically when the SPIN switch is activated. "ENTER" need not be pressed when measuring unbalance.

DISPLAY BLANK for a few seconds, or until the workpiece spins

MEASURING RPM increasing to preset speed 5ØØ. May read negative below 2ØØ.

During a measuring cycle, the display may blink one more times while measuring to indicate AUTORANGING of the measuring electronics. This controls the amplification of the unbalance signal and how many digits are displayed on the display. The smaller the unbalance, the more digits right of the decimal point are displayed- .1, .Ø1, etc.

After the display of unbalance, the measuring cycle is complete and the workpiece may be stopped.

SPIN switch off.

MOTOR switch off when workpiece is fully stopped.

After a measure cycle, any SETUP parameter may be changed, i.e. OZ, RADIUS, DIMENSIONS. When you return to the BALANCE mode the correction information will be updated for the new parameter without respinning.

Most balancing modes include an angle in the display of unbalance measurements. With a standard equipment ANGLE INDICATOR the angle on the display corresponds to the angle on the ANGLE DIAL DISC, which corresponds to locations around the workpiece in a Ø-6Ø minute circle.

Both left and right angles are calibrated to the angle dial. Use the same "zero" reference and count in the same direction.

BALANCING IN 2 PLANE MODE

The 2 PLANE mode is the most flexible mode on the balancer. All of the SET UP parameters are effective in this mode. The operator also has the ability to choose correction radii for left and right planes.

The LEFT plane can be located to the RIGHT or LEFT of the LEFT bearing V BLOCK. If it is to the LEFT, it is a negative number when entering the LEFT DIMENSION. i.e. To set Left plane 2" left of the V block, press -2.

The RIGHT plane can be located anywhere to the RIGHT of the LEFT bearing V BLOCK.

A typical measurement display:

-1.00	-5.25	OZ.
<60	<15	2 PL

Explanation of display:

-1.00 Indicates removal of 1 oz. at the LEFT PLANE at the SETUP RADIUS. (The minus sign indicates removal).

< 60 The ANGLE where the correction is needed at the LEFT CORRECTION PLANE.

-5.25 Indicates removal of 5.25 oz. at the RIGHT PLANE at the SETUP RADIUS.

< 15 The ANGLE where the correction is needed at the RIGHT CORRECTION PLANE.

OZ. Indicates the correction/unbalance amount choses in SETUP (OZ.GM) is in ounces.

2PL 2 PLANE balancing mode.

BALANCING IN THE LEFT RIGHT MODE

The LEFT/RIGHT mode is designed for CRANKSHAFT balancing. The LEFT and RIGHT plane dimensions are preset for 5% and 95% in from the LEFT and RIGHT bearing V BLOCKS respectively. This is commonly where corrections are made on crankshafts. The SET UP plane dimensions are therefore not in effect in this mode.

The RADIUS parameter is in effect and still must be measured as accurately as possible for optimal correction calculations in the ANALYZER.

Since the FLYWHEEL and HARMONIC BALANCER are very near these preset dimensions, accurate internal engine balancing can be done in this mode by balancing the crankshaft, installing the flywheel and harmonic balancer and balancing the entire assembly by making corrections on the flywheel and harmonic balancer.

A typical measurement display:

-35.Ø	12.Ø	GM
<6Ø	<15	LR

Explanation of display:

-35.Ø Indicates removal of 35.Ø grams at the LEFT PLANE. at the SETUP radius.

<6Ø The ANGLE where the correction is needed at the LEFT CORRECTION PLANE.

12.Ø Indicates ADDING of 12.Ø grams (no minus sign (-) in front of amount)at the RIGHT PLANE at the SETUP radius.

<15 The ANGLE where the correction is needed at the RIGHT CORRECTION PLANE.

GM Indicates the correction/unbalance amount chosen in SETUP (OZ/GM) is in grams.

LR LEFT RIGHT balancing mode

BALANCING IN THE FORCE MODE

The FORCE mode is used for SINGLE PLANE balancing such as FLYWHEELS on the MANDREL.

In the FORCE mode, the RADIUS is effective and should be measured as accurately as possible and entered in the SET UP parameters.

The RADIUS is the distance from the MANDREL SHAFT CENTER TO THE CENTER OF THE CORRECTION LOCATION ON THE FLYWHEEL.

The DIMENSION parameters are not effective and need not be entered.

Enter both L-Rad & R-Rad weights

A typical display:

-35.0	GM
<60	FORCE

Explanation of display:

- -35.0 Indicates removal of 35 grams at the SETUP Radius.
- <60 The angle where corrections is needed.
- GM Indicates the correction unbalance amount chosen in SETUP (OZ/GM) is in grams.
- FORCE Force balancing mode.

BALANCING IN THE UNBALANCE MODE

The UNBALANCE mode displays the amount unbalance at 1 (one) unit of RADIUS.

When balancing in this mode the RADIUS entered in the SET UP parameters is not effective. The units of RADIUS entered in the SET UP parameters is effective i.e. inches or centimeters.

Therefore, the amount unbalance displayed will not be the amount required to correct the workpiece at the correction RADIUS unless the RADIUS is 1.

If INCHES were chosen from IN/CM in the SET UP, the amount displayed would be at 1 (one) inch. If OUNCES were chosen from OZ/GM (OUNCES/GRAMS), the amount displayed would be OUNCES.

See the section on UNBALANCE UNITS and TOLERANCE in the DESCRIPTION OF BALANCING PARAMETERS for a further explanation of balance tolerances.

The correction planes are preset to 5% and 95% in from the LEFT and RIGHT bearing V BLOCKS respectively. The DIMENSIONS of LEFT RIGHT B/B are not effective in this mode.

It may be useful to the operator to toggle from modes LEFT RIGHT to UNBALANCE to see how workpiece corrections are approaching tolerance.

A typical measurement display:

-35.0	12.0	GM/IN
<60	<15	UNBAL

Explanation of display:

- -35.0 Indicates removal of 35 grams. in the LEFT correction plane at ONE INCH RADIUS.
- <60 The ANGLE where correction is needed. The unbalance exists at the LEFT PLANE.
- 12.0 Indicates ADDING of 12 grams (no minus sign in front of amount) at the RIGHT PLANE.at ONE INCH RADIUS.
- <15 The ANGLE where correction is needed at the RIGHT PLANE.
- UNBAL UNBALANCE mode
- GM/IN Indicates the UNITS chosen n SETUP (OZ/GM, IN/CM) are gram inches.

ENGINE BALANCING INSTRUCTIONS

The complete engine assembly to be balanced includes the crankshaft and all of the components attached to it: pistons and pins, rods, flywheel, clutch, pressure plate, and front pulley or torsional damper. All of these parts should be clean and dry, and all machining completed before balancing.

Examine the engine to see if it is internally or externally balanced. Externally balanced engines have counterweights on the flywheel or damper, while internally balanced engines have been compensated on the crank. The components of an internally balanced engine can be balanced individually. For the most accurate balance job, however, we recommend balanicng the crankshaft first, then adding and balancing the components, one at a time. Leave the timing gear on the crankshaft so the damper is properly spaced.

Externally counterweighted engines must be balanced as an assembly with the flywheel and damper attached.

If the counterweighted flywheel and damper are replaced with standard components, it will be necessary to add heavy metal to the counterweights. See Tips for adding heavy metal, Page III-8.

PISTONS AND PINS

The object is to find the lightest piston and pin assembly in the set, and remove weight from the others to bring them within a tolerance of +.5 gm.-.0 (+1.0 gm.-.0 for truck engines).

Individually weigh each piston and pin. Place the lightest piston and pin on the scale and press the tare button. This cancels out the weight of the item on the scale, so the amount display shows only additional weight. Remove the piston and pin. One at a time, reweigh each piston. The number displayed is the amount of material which needs to be removed from the heavier pistons.

The most common method of weight correction is removing material from the inside of the piston (usually on the pin boss) with a lathe, or the careful use of a drill press. Be careful not to remove metal from the piston in any area which would weaken it. We recommend leaving the pin on the scale pan while weight correcting a piston. Double check the weight of each piston and pin assembly during and after weight removal.

RODS

The next step is to balance the rod ends. The scale and the rod weighing device should be set up so they are square with each other. Fasten the pan adaptor to the scale, and mount the rod adaptor on it. Set the scale to zero by pressing the tare button. Rod ends are balanced by finding the lightest one and removing metal from the others to bring them within a tolerance of +.5 gm. -.0 for each end (+1 gm. -.0 for trucks).

Both ends of the rods must be weighed and matched separately. The large end of the rod is called the rotating end because it rotates with the crankshaft. The small end is known as the reciprocating end because it moves up and down with the pistons.

When weighing rods, the center of the rotating end should be level with the center of the reciprocating end. Only the weight of the end being weighed should rest on the scale. Weigh each rotating end with the bearing retaining groove down. Place the lighest one on the scale and press tare. Reweigh each of the heavier rods. The number displayed indicates the amount of material which needs to be removed. Grind the excess metal to bring them into tolerance, then double check the weight of each one.

To weigh the reciprocating ends, place the rod adaptor on the rod weighing device. With only the pan adaptor on the scale, press the tare button. Use the same method to balance the reciprocating ends. Again, be sure to double check each end.

After weighing and balancing both ends, check the total rod weight. Grinding the rod ends heats them, which temporarily changes their shape. In turn, this can change the way they hang on the scale, which will alter the weight reading. Removing more than 6 gms from the reciprocating end can alter the weight of the rotating end.

BOBWEIGHT CARDS

Use the bobweight cards to record the weight of each item. Enter the weight of the lighest rod reciprocating end once, and the weight of the lighest rod rotating end twice.

Weigh the other items and enter their weight on the card. New sets of locks, rings and bearings are machined to close tolerances by the manufacturer, so they usually do not require weight correction. However, if they differ from each other by more than .25 grams, you can remove metal to bring them into closer tolerance. Write 4 gm. under "Oil", to account for the oil which is present in the galleys during normal operation, but absent during balancing.

Now, add up the total bobweight and double check it with a calculator. You will use this total later to make bobweights for balancing V-block engines. Keep this card on file for your customer, so if any parts need to be replaced in the future, their weight can be matched to maintain engine balance.

CUSTOMER: Bill Smith

ADDRESS: ________

PHONE NO: ________

V-8

JOB # 101

DATE ______

ENGINE MAKE Ford

MODEL 302

ROD ROTATING	391
ROD ROTATING	391
ROD BEARING	43
ROD BEARING	43
OIL ALLOWANCE	4
PISTON & PIN	748
LOCKS (1 SET)	-
RINGS (1 SET)	59
ROD RECIPROCATING	168
BOBWEIGHT TOTAL:	1847

- ☐ COMPLETE ENGINE
- ☐ LESS FLYWHEEL
- ☐ LESS PRESSURE PLATE
- ☐ LESS DAMPENER

NOTE: 50% RECIPROCATING, 100% ROTATING

Figure 9

BOBWEIGHTS

Bobweights are necessary to balance V block engines, but not inline engines. These weights are attached to the rod journals of V block engines to simulate the weight and motion of rods and pistons on the crankshaft. Hines bobweights are aluminum, self-centering, precision machined, and dynamically balanced. Fill the bobweights with flowable lead shot to obtain the exact weight required, which is the total bobweight on the bobweight card.

To prepare bobweights for balancing:

- Place a styrofoam cup on the scale and press tare.

- Place a complete bobweight (cups, caps, and nuts) on the scale.

- Fill the styrofoam cup with lead shot until the weight displayed equals the total bobweight.

- Remove the bobweight and note the weight of the lead shots. Remove the cup.

- Place an identical styrofoam cup on the scale and fill with 1/2 of the lead shot. Double check that each cup weighs the same. Place only one cup on the scale at a time since you have only tared the weight of one cup.

- Fill the bobweight cups with the lead shot. Place the cap on and tighten the nuts while holding the cup with the cap facing up. Tap the sides of the bobweights as you do to be sure the lead shot is evenly distributed.

- Double check the weight of each completed bobweight.

It is very important to tap the sides of the bobweight cups as the caps are tightened, so the lead shot will be evenly distributed.

The bobweights can now be mounted on the crankshaft. To ensure that they are mounted in the same place on each rod journal, machined spacers must be used. Place a spacer against one side of the journal and attach the bobweight, pressing it firmly against the spacer. Attach the other bobweights with the spacer in the same positon, so the bobweights will be in the same place on each journal. Orientation is not critical; they do not need to be at right angles to each other. (Figure 1Ø)

Use care when securing the bobweights on the crank. Tighten the nuts by hand, then use a bobweight tool in each hand, applying equal pressure on both sides. This will avoid cocking the bobweights because of excessive weight on one side. For greater accuracy and repeatability, we recommend that you micrometer the bobweight ends near the guide pins. Each side of a bobweight should match the other end, but the bobweights do not have to match each other.

Following these steps carefully ensures greater accuracy in the balancing job.

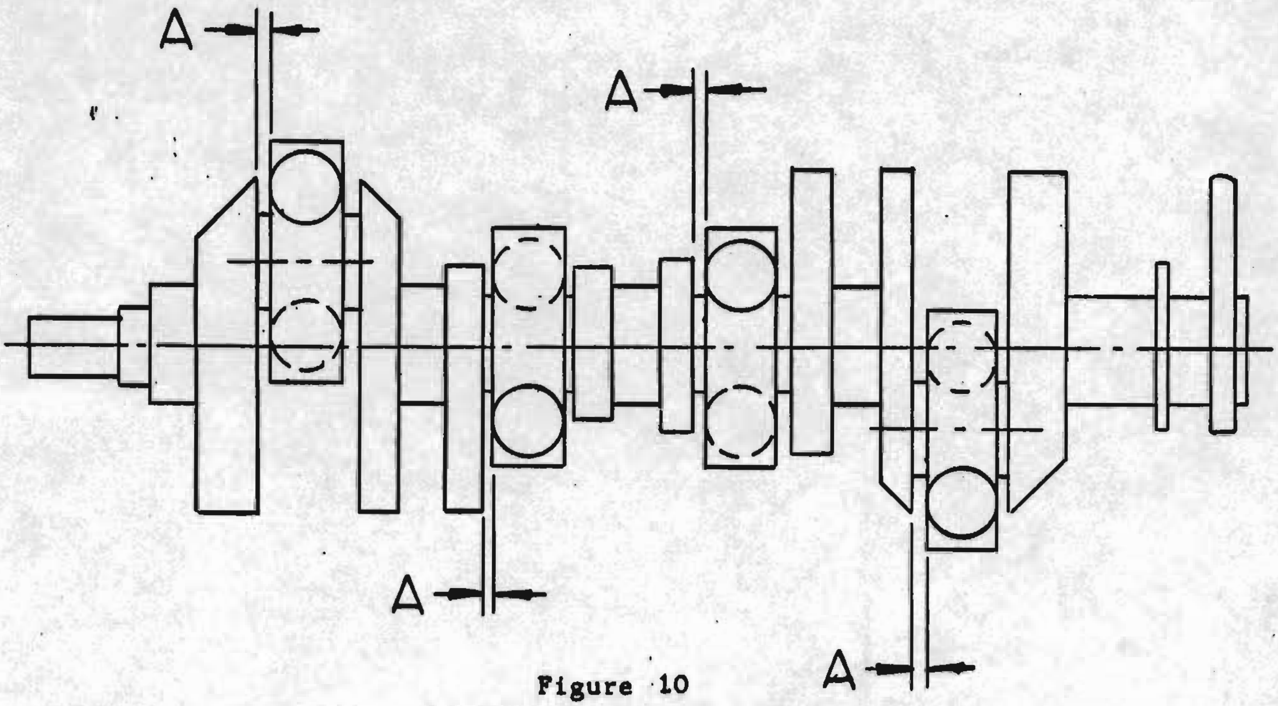


Figure 10

POSITIONING OF BOBWEIGHTS

It is important that bobweights be placed an equal distance from the left edge of the throw. Measure from the machined surface of the journal to the bobweight.

FLYWHEEL

If the flywheel and front pulley have no counter weighting on them, you can balance them on either the crankshaft or on the flywheel balancing mandrel. Set the L.R./Force control to Force when using the mandrel, and to L.R. when balancing on the crank. Stay 1/2 inch from the holes which are drilled and tapped for attaching the pressure plate.

CLUTCH PLATE

In actual operation, the disc "floats" on the shaft spline, making it essentially self-centering and self-balanced. Therefore, most shops do not attempt to balance it. To make weight correction on the clutch, holes can be drilled into the spring lugs or casing, or weight can be welded on. It is best to follow the manufacturer's recommendation for weight correction.

Because clutch plate bolt holes are often oversized, the flywheel and clutch need to be assembled in the engine with the same "up" orientation used when they were balanced. This prevents the introduction of unbalance from a different hole alignment. To do this on the balancer, hang the clutch on the flywheel with one of the bolts in the 12 o'clock position. Mark this bolt hole on both the clutch and the flywheel with paint or chalk. When reassembling the engine, hang the clutch with the marked hole in the 12 o'clock position. Due to gravity, the clutch plate will center itself in the same position that it was in on the balancer. This ensures that the tolerance will be maintained when the engine is reassembled.

FRONT PULLEY

The front pulley can also be balanced on either the crank shaft or on the flywheel mandrel. If it is externally counterweighted, it must be attached to the crank before the crank is balanced.

Harmonics - care should be taken when drilling on a harmonic so as not to weaken it. If you use a 1/2" drill, go no more than 1/8" deep, with a 3/8" drill, no more than 1/4" deep.

Tips for Adding

Heavy Metal

1. In iron cranks holes should be placed no closer than 3/8" from edge of CW when drilling on the sides. In steel cranks holes can be placed to within 1/4" from the edge. The reason for this is because at extremely high rpm, the metal could weaken and the heavy metal could come out.

2. To calculate # of holes and depth use chart as follows:

   a) To add 100 grams, drill hole .875 x 1.100". Now you need to 184 grams. Add 1 pc. HM085 and grind off 2 grams.

   b) To add 250 grams, drill 2 holes 1 x 1.100. Now you need 470 grams. Add 2 pieces HM105 for a total of 486 and grind off or drill out 16 grams.

3. It is not absolutely necessary to weld, but if you do, add weight of weld in the calculations.

4. If the heavy metal is shorter than the thickness of the CW, press it into the middle so there will be an equal depression on either side.

5. Heavy metal can be added in the top or side of a CW. If you add it to the top, then grind, your customer can't see it.

6. If you have many different sizes of drills and reamers, you can use a drill slightly smaller than heavy metal, ream to size, then hammer or press in heavy metal. Most people use 2 or 3 standard drills and buy heavy metal for those sizes.

Approximate Weight in Grams

*PT.#	DIA.	LENGTH	TUNGSTEN	STEEL
HM454	.438	.875	43	17
HM05	.500	.750	43	19
HM06	.500	1.200	65	31
HM750	.750	1.200	147	67
HM07	.875	.500	87	38
HM075	.875	~~1.100~~	117	53
HM08	.875	1.000	169	77
HM085	.875	1.100	186	84
HM09	.875	1.200	198	92
HM104	1.000	.700	153	69
HM10	1.000	1.000	227	100
HM105	1.000	1.100	243	110
HM11	1.000	1.200	265	120

*ABS Part #'s

~~1.200~~ .625 1.200 1025

SECTION IV

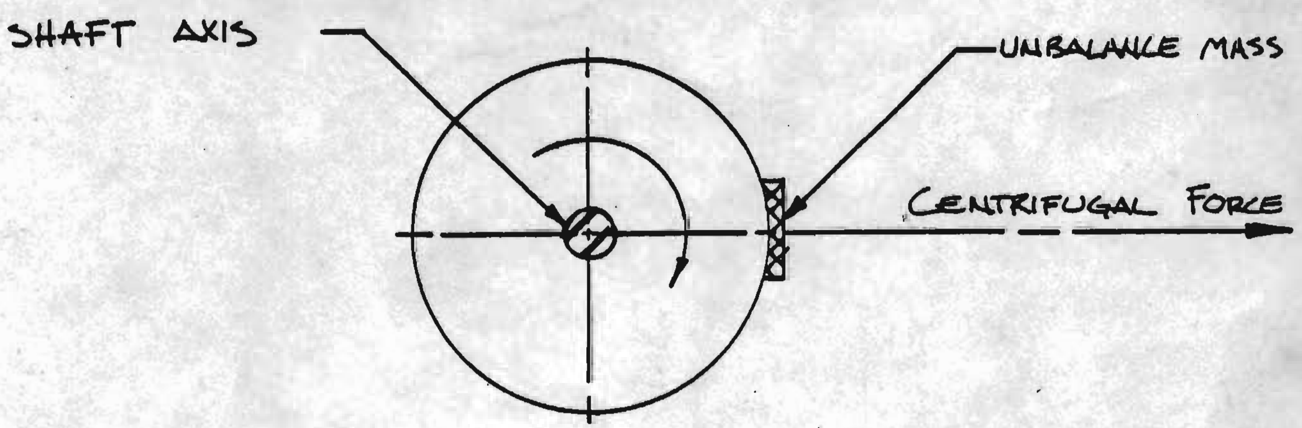
BASIC BALANCING THEORY

UNBALANCE AND VIBRATION

The effect of unbalance in a rotating mechanical part is the same as placing all the clothes in a washing machine on one side of the tub and turning on the spin cycle. The resulting vibration causes excessive wear in bearings, bushing, shafts, spindles, gears etc. throughout the assembly that includes the unbalanced part. Such vibration can also be transmitted through the floor and affect the operation of surrounding machinery. Performance decreases because energy is absorbed by the supporting structure and the stresses created can eventually lead to the failure of the supports and frames.

When a mechanical component rotates, centrifugal force acts upon the entire mass. Each particle is forced outward in a radial direction from the axis of rotation. If the part is balanced, its mass is evenly distributed; and its mechanical axis of rotation coincides with its center of gravity. The balanced part rotates without vibration.

If the part is unbalanced, an excess of mass exists on one side. When rotating, the centrifugal force on the heavy side is greater than that on the lighter side and pulls the entire mass in the direction of the heavy side, or away from the mecahnical axis of rotation. See Figure 8.



CENTRIFUGAL FORCE PULLS AN UNBALANCED MASS AWAY FROM THE AXIS OF ROTATION

Figure 11

Balancing, is the process of correcting a mechanical component so that its center of gravity coincides with the mechanical axis of rotation; in other words, so that its mass is evenly distributed.

The unbalance which causes the centrifugal force is independent of rotational speed. All the clothes in the washing machine are still on one side whether it rotates or not. It is only the force created by the unbalance which changes with rotational speed. That force change is vibration. Since the unbalance is inherent in the part and independent of the rotational speed, it is always a constant function. A part that is 2 oz.in. out of balance at rest is still 2 oz.in. out of balance at 500 rpm.

The formula for unbalance is:

weight x distance = unbalance
ounces x inches = oz.in.

This formula is a linear function. If something is 8 oz.in. out of balance, it is the same as:

8 oz. x 1 in. = 8 oz.in.
or 4 oz. x 2 in. = 8 oz.in.
or 2 oz. x 4 in. = 8 oz.in.

When a part is 8 oz.in. out of balance, we balance the part by either removing that unbalance or adding an equal amount to the opposite side. Since the formula is linear, the radius of correction can be adjusted to whatever is desireable. For example, a part that is 6 oz.in. out of balance can be corrected by adding 6 oz. at a 1 inch radius, 3 oz. at a 2" radius or 1 oz. at a 6 inch radius. All the corrections are 6 oz.in. weight x displacement = unbalance for the total part.

Tooling Error:

Making a further application of the basic formula, weight x displacement = unbalance, tooling error is easily computed.

If a part weighing 100 ounces is put on tooling that has an error of .0005, the unbalance effect will be:

weight x displacement = unbalance
100 oz. x .00005 = .05 oz.in.

The need for accurate tooling and part fit becomes readily apparent.

TWO FORMS OF UNBALANCE

Unbalance occurs in two forms, each creating a different type of vibratory motion. One is force (static) unbalance, generated when the center of gravity does not lie on the axis of rotation (bearing axis). In this case, the part will vibrate in such a way that the intended axis of rotation is parallel to the actual axis of rotation. (See Figure 8)

The second form is couple unbalance, created when the <u>inertial</u> axis of rotation of a part does not coincide with the <u>geometric</u> axis. (See Figure 9) The rotating part will then vibrate so that the axis of rotation will <u>pivot</u> about the center of gravity.

Parts or assemblies where the length is larger than the diameter will most likely be affected by force (static) and couple unbalance simultaneously. This condition is referred to as dynamic unbalance. Such parts are usually corrected with a two-plane balancer tha <u>resolves</u> the unbalance to two separate correction planes, while the part is spinning.

Although dynamic unbalance can only be detected by rotating a workpiece, it is important to realize that both terms, "force" and "dynamic" refer to conditions and not to methods employed in determining and correcting them.

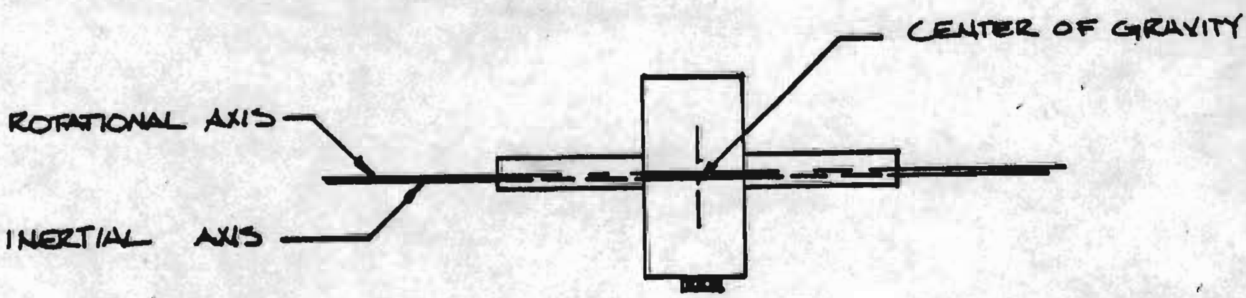
Force (Static) Unbalance

The center of gravity of a body is the point at which all the mass of the body can be considered to be concentrated. All rotating bodies have a tendency to rotate about their center of gravity. If a machine part is placed on the shaft so that it is forced to rotate about an axis that does not coincide with its center of gravity, it will be out of balance.

When a machine part is manufactured, its mechanical axis of rotation is determined. Ideally, the center of gravity of the part and its rotational axis coincide, and the part is in balance. The more usual case, however, is that imperfections in the production process create displacement between these two. The result is force (static) unbalance.

Parts or assemblies that are approximately disc-shaped are affected primarily by force (static) unbalance. Measurement can be made with or without rotating a workpiece, usually with a single plane balance measuring unbalance in one plane.

Force (static) unbalance of any magnitude may be demonstrated in a body if that body is supported on its bearing points by two horizontal knife edges.



FORCE (STATIC) UNBALANCE

Figure 12

Because the center of gravity is not centered on the rotational axis, the pull of gravity on the unevenly distributed mass causes the workpiece to roll.

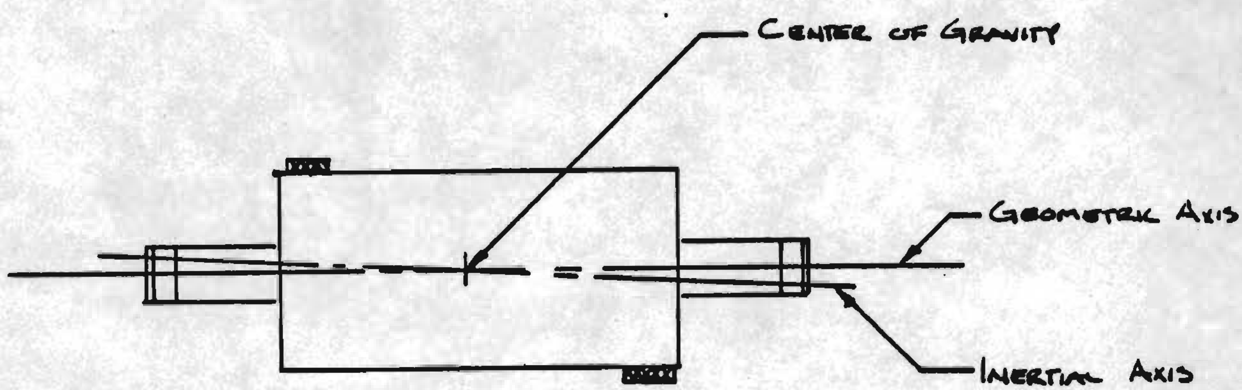
The heavy or unbalanced part of the workpiece will always seek a position vertically below the point of contact of the bearings.

When a statically unbalanced body is rotated, it will tend to rotate about its center of gravity, rather than about the axis of rotation. Inertial force pulls the shaft away from the mecahnical axis of rotation. Thus, if the bearings supporting the body were free in space, they would describe circles when the body is rotated, and at any instant, the direction of the displacement would be the same for both bearings. It is this tendency of a statically unbalanced body to produce displacement of its supporting bearings that causes harmful noise and wear.

Couple Unbalance

A workpiece with a pure couple unbalance has two unbalance forces, equal and opposite and separated by some length. If placed on knife edges, the workpiece will not roll because the effect of the unbalance weights cancel. However, if the part were rotated in space, the workpiece would pivot about its center of gravity, with both ends wobbling about that point, 180 out of phase.

Couple unbalance may be produced by eccentrically mounting two physically identical discs on a shaft, with the direction of eccentricity opposite on one disc with respect to the other. The axis about which such a body will rotate in free space is called inertia or mass axis. The motion of the rotational or bearing axis of the shaft will generate two cones on either side of the center of gravity.



COUPLE UNBALANCE

Figure 13

SECTION V
TROUBLE SHOOTING CHECKS

We recommend going through the following procedure periodically to check the calibration and operation of the machine. When a problem with the balancer does arise, it is necessary to thoroughly diagnose the problem before attempting to correct it. This procedure will also enable you to quickly identify the problem.

1. Set a balanced workpiece or test rotor on the balancing machine. (Balance to zero if necessary). Place a 28 gram weight on one end of the part, as near the bearing as possible, at a known or measured radius.

2. Set Radius to that known radius. Start the motor and observe the reading. The amount displayed should equal the 28 gm. test weight.

3. Set the Radius to 1.Ø" and observe the amount reading. It should equal Weight x Radius.

   Remember: Weight x Radius = Gram (or Ounce) Inches
   Gm.-In./Radius = Correction (Amount)

   For example, if the Radius is set to 1", with a 28 gm. weight at a 2 in. radius, the amplifier would show an amount of 56.

4. Observe Angle:
   Add Angle is +3Ø minutes (or 18Ø degrees) from the test weight angle.
   Remove Angle = test angle.

5. Repeat Steps 1-4 for the other end of the workpiece.

6. Check SET UP parameters.

7. Remove the 28 gm. test weight and check for steady amount readings using smaller test weights.

Once the problem has been identified, the following steps can be used to correct it. Follow the corrective steps for each condition in the order that they are listed. If you do not understand the procedure, if you cannot locate the problem of are unable to correct it, or if you have any questions, please call Hines Service Department, (313) 769-23ØØ.

A) ANGLE READING- no angle, same angle always, angle -1 or above, angle incorrect, angle unsteady.

   1. Check cables and connectors- Check cables for any breaks in the vinyl jacket, which may indicate a broken wire or short inside. Be sure the cable is properly connected to the analyzer and the connectors have tight fits.

2. Inspect the back of the angle disc for indicator tapes. There should be 16 white segments in a ring, and a single white tape inside the ring. If the angle reading is only incorrect by a few numbers, the angle may need to be calibrated. See Angle Calibration, page V-5.

3. Check pulse sensor assembly and voltages. See Pulse Sensor, page V-5b.

4. Check read-hold. The tachometer reading (RPM) should change numbers coming up to speed. If it does not, call the Service Department.

5. Check the bearing blocks. They should not be rutted or worn, and must be able to move freely. If they are worn, they should be replaced.

6. Check SET UP parameters.

B) AMOUNT READING- none, no amount on one side, unsteady, incorrect, always the same.

1. Check cable and connectors. Check cables for any breaks in the vinyl jacket, which may indicate a broken wire or short inside. Be sure the cable is properly connected to the analyzer amplifier and the connectors are "hand tight".

2. Is machine level and firm on all four corners? The leveling screws should not be run out more than 1-1 1/2 inches. is the machine grouted? See Leveling, Section 1.

3. If you switch the connectors, L for R and R for L, does the problem also switch? If it does not, contact the Service Department.

4. If the problem does transfer when you switch the connectors, check the stanchions, bearing blocks, and pick-ups. The stanchions should be firmly and squarely on track and tigtened down. The bearing blocks should not be rutted or worn, and must be able to move freely. When balancing a crankshaft, the oil holes on the crank should ride within the manufactured groove on the bearing block, or miss it completely. To inspect the pick-ups, see Pickups, page V-7.

5. Check "Spin ON" switch. The tachometer reading (RPM) should change numbers coming up to speed. If it does not, contact the Service Department.

6. If other checks do not produce the correct amounts, the amount will have to be calibrated. See Amount Calibration, page V-5.

7. Check SET UP parameters.

C) NO TACHOMETER (RPM) READINGS-

1. Check cables and connectors. Check cables for any breadks in the vinyl jacket, which may indicate a broken wire or short inside. Be sure the cables are properly connected to the amplifier and the connectors are "hand tight".

2. Check pulse sensor assembly and voltages. See Pulse Sensor, page V-5b.

3. Check belt. It should be taut and completely vertical. For the motor to operate properly, the belt must be positioned over the drive surface of the crank and the motor pulley.

D) AMPLIFIER HAS NO DISPLAY-

1. Check the fuse on the back of the amplifier. Replace it with a like fuse if it is blown. A fuse which repeatedly blows out indicates a problem with the power supply, and the Service Department should be contacted.

2. Check power cord. It should be plugged in, with an incoming voltage of 110 volts. Make sure the cord is in good condition.

3. Open the amplifier cover and check the four connectors to the display board. They should be in place nad tight. Check for loose wires in the amplifier. If you find any, contact the Service Department.

E) VIBRATION WHEN PARTS RUN-

1. Is machine level and firm on all four corners? The leveling screws should not be run out more than 1-1 1/2 inches. is the machine grouted? See Leveling, Section I.

2. The stanchions should be firmly and squarely on track and tightened down.

3. The bearing blocks should not be rutted or worn, and must be able to move freely. When balancing a crankshaft, the oil holes on the crank should ride within the manufactured grooves on the bearing blocks, or miss them completely.

4. Check belt. It should be taut and completely vertical. For the motor to operate properly, the belt must be positioned over the drive surface of the crank and motor pulley.

5. Turn part over so that the opposite part end is on the opposite stanchion, and run.

6. Adjustment of A-cel and D-cel in motor control may be necessary. See Lovejoy, page V-6.

F) PART DOES NOT TURN, NO POWER-

1. Check power cords and incoming voltages. be sure the cords are plugged in, in good condition, and receiving the correct voltage. See electrical requirements, page I-2.

2. Check fuse on the back of the amplifier. Replace it with a like fuse if it is blown. A fuse which repeatedly blows indicates a problem with the power supply, and the Service Department should be contacted.

3. Do the lights on the Lovejoy work when it is on Run? If they do, the problem is probably in the Lovejoy.

4. Unplug the motor from the Lovejoy and connect it directly to a power source. If it does not run, the problem is with the motor or the power. If it does run, the problem is in the Lovejoy.

5. Lovejoy voltage may have to be changed (2 transformers). See Lovejoy, page V-6.

AMOUNT AND ANGLE CALIBRATION

The recommended procedure requires the use of a HINES manufactured and balanced TEST ROTOR. This eliminates possibilities of faulty calibration due to test shaft eccentricity, test weight placement and untrue test weight.

True calibration can be performed WITHOUT A HINES TEST ROTOR if the test shaft is concentric, balanced, has suitable locations for test weights that can be accurately measured for radius, and two (2) test weights of equal and verified weight.

1) Use a balanced test rotor or balance a shaft of known concentricity with a LENGTH GREATER THAN ONE FOOT AND A SHAFT DIAMETER GREATER THAN ONE INCH. A crankshaft will balance the shaft (with clay is fine) to the lowest amount possible. USE THE 2 PLANE MODE. Do not use the flywheel mandrel.

2) The SETUP parameters should be set as follows:

   OZ/GM = OZ

   IN/CM = IN

   RADIUS (LEFT AND RIGHT) = RADIUS (IN INCHES) TO WHERE THE TEST WEIGHTS WILL BE PLACED AFTER SHAFT IS BALANCED. IDEALLY, LEFT AND RIGHT RADII SHOULD BE EQUAL.

   LEFT DIMENSION = FROM LEFT BEARING V BLOCK TO LEFT SIDE LOCATION FOR TEST WEIGHT.

   RIGHT DIMENSION = FROM LEFT BEARING V BLOCK TO RIGHT SIDE LOCATION FOR TEST WEIGHT.

   BEARING TO BEARING = DISTANCE BETWEEN BEARING V BLOCKS CENTERS IDEALLY, B/B SHOULD BE GREATER THAN ONE FOOT.

3) With shaft balancing to lowest possible amount, determine two test weights of equal weight that EACH weigh more than twenty (20) times the residule unbalance of the shaft.

   (Example: if the residule unbalance of the shaft is:

   .05 OZ LEFT PLANE   .08 OZ RIGHT PLANE

   the test weight should weigh at least:
   .08 x 20 = .16 OZ. but 1 OZ IS BETTER:

   This would be the minimum required calibration weight to null the effect of the residule unbalance. However, even in this ideal case, where the residule unbalance is low, AT LEAST A 1 OUNCE CALIBRATION WEIGHT IS RECOMMENDED FOR THE MOST ACCURATE CALIBRATION. The greater the test weight to residule ratio the better.

4) Place the calibration weights in the predetermined locations from the SETUP parameters. The MASS CENTER of the test weight should be at the correct RADIUS, if it must be changed by some amount for locating purposes, CHANGE THE SETUP PARAMETERS TO AGREE WITH THE ACTUAL RADIUS OF THE TEST WEIGHT MASS CENTER.

   THE TEST WEIGHT MUST ALSO BE IN THE SAME PLANE AS ENTERED IN THE SETUP PARAMETERS.

   RADIUS AND DIMENSION MEASUREMENTS MUST BE PRECISE.

   THE ANGLE LOCATIONS OF THE TWO TEST WEIGHTS, CORRESPONDING TO THE ANGLE DIAL, SHOULD BE EQUAL. THEY SHOULD LINE UP WHEN SIGHTING DOWN THE LENGTH OF THE TEST SHAFT.

5) Run the machine through a measure cycle in the 2 PLANE mode.

6) Adjust the AMOUNT CAL POT at the back of the analyzer.

   Update the CAL Pot by pressing the 2 PLANE KEY after each small movement of the cal Pot. Repeat until the correct amounts are displayed. The amount cal pot controls both left and right amounts. It is not necessary to respin each time.

7) Adjust the ANGLE CAL POT at the back of the analyzer to set correct angle of both test weights on the shaft. Update the cal pot by pressing the 2 PLANE KEY after each small movement of the cal pot.

8) Run the machine through another measure cycle and readjust the cal pots if needed.

   Changes of one minute in angle and 3 or 4 % in amount OZ/IN are not considered out of calibration or repeatability. This also applies to left and right differences.

9) Remove one of the weights and run a measure cycle. There should be only a small amount displayed on the side without weight; residule plus some crossover.

   The side with weight may have come down some- normal if small depending on the distance between the test weights.

10) Replace weight and remove the other. Repeat as above.

11) Move the weights around the shaft verifying that the angle displayed corresponds to the angles of the test weights.

12) Try the weights at opposite angles.

When amounts are accurate and angles track the machine is calibrated.

If calibration can not be achieved, or if either have changed by a larger amount, or are erratic, the problem is probably electronic or mechanical. In this case, the Service Department should be contacted.

PULSE SENSOR ASSEMBLY AND VOLTAGE
(FIGURE 14)

The pulse sensor is located inside the angle indicator box, directly behind the angle disc. : It consists of a small angle bracket, with four wires (red, white, black, and green) connected to it.

To test the pulse sensor, you will need a voltmeter. Turn the amplifier on, and set the volmeter to D.C. volts. Connect the black lead to the green wire, and the red lead to the red wire, and turn the wheel slowly by hand. It should read +5 volts.

Connect the black lead to the green wire, and the red lead to the white wire. It should read +4.5 volts when each of the 16 white segments passes the photoelectric eye, and +.5 volts or lower in the black spaces.

UNBALANCE PICKUPS

The unbalance pickups are located on the stanchions. Remove the cover plates on the stanchions to expose the vibration pickups. Loosen the locknut, then back the screw away from the pin that extends from the pickup. Carefully examine the pin. It should have a good spring action, and measure 395-400 ohms.

To reset the unbalance pickup, adjust the screw until it just touches the pin. Turn the screw another 4 flats in relation to the locknut, making sure the pin still has travel. Tighten the locknut and replace the cover plates.

LOVEJOY MOTOR CONTROL
(See Figure 15)

CAUTION: DISCONNECT POWER BEFORE MAKING ANY ADJUSTMENTS TO THE LOVEJOY UNIT

Voltage- The Lovejoy Motor Control operates at line voltages of 200 VAC and 230 VAC. The terminal leads on each end of the two transformers must be set at the terminals closest to your line voltage. Check page 7 of the Lovejoy manual for further explanation.

Adjustment- If all other troubleshooting checks have been performed, and the vibration problem still exists, adjustment of the Lovejoy may be necessary. The power must be on to make these adjustments, but use extreme caution. Call the Service department before making any major adjustments.

A-cel- Vibration is sometimes caused by the rapid acceleration of a part. To slow acceleration time, remove the cover of the Lovejoy. Adjust the A-Cel potentiometer counter-clockwise 1/8 of a turn. Spin the part and adjust the dial 1/8 turn until the vibration is eliminated. If acceleration time is too slow, or if vibration persists, call the Service department.

D-cel- Your Hines Cradle Balancer should not brake abruptly. Braking should be gradual, with 2 to 3 turns of a part. To adjust the braking time, turn the D-cel potentiometer 1/8 turn. Turn clockwise to slow braking, and counter-clockwise to speed braking. Repeat at 1/8th turn intervals until a satisfactory braking time is achieved.

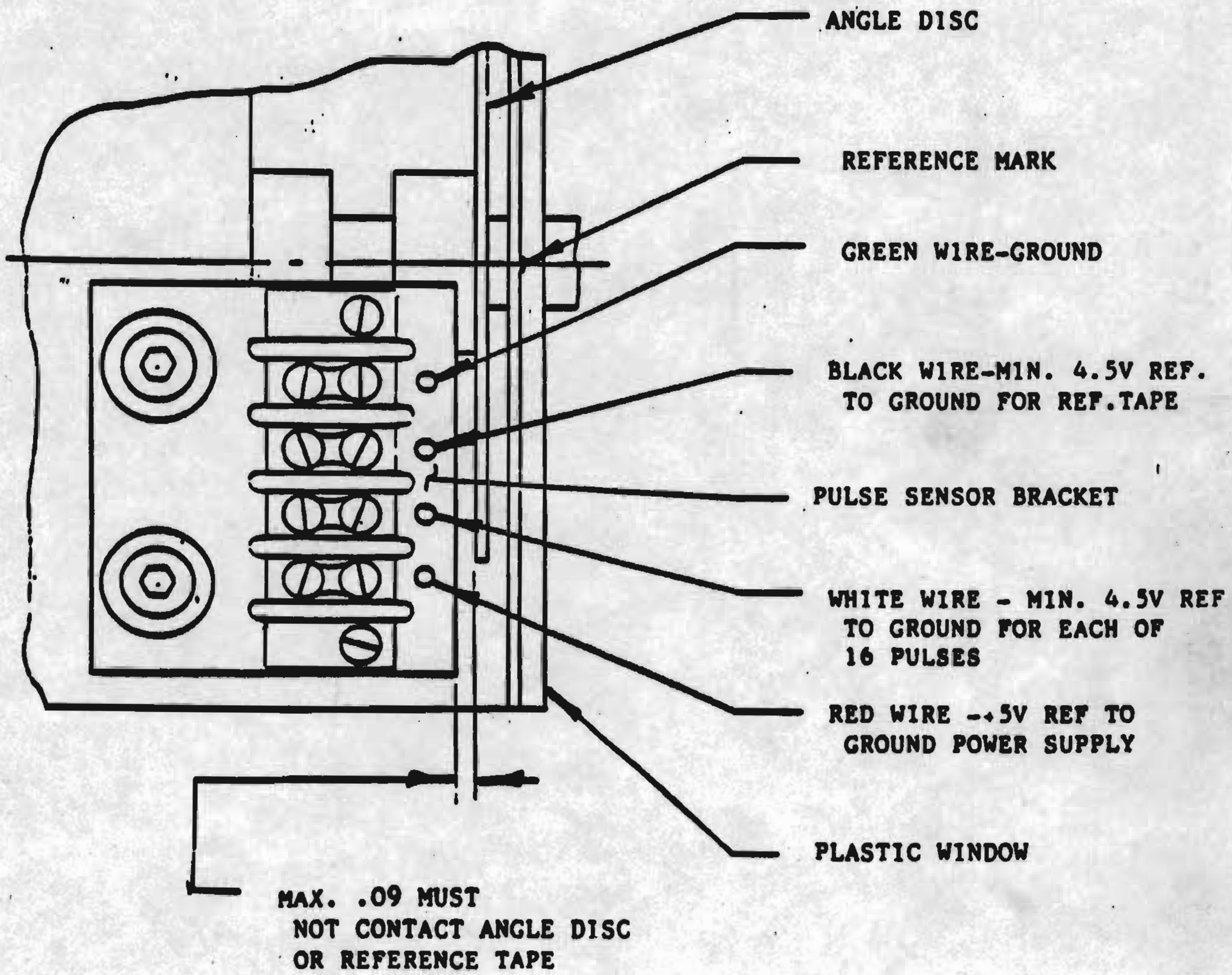
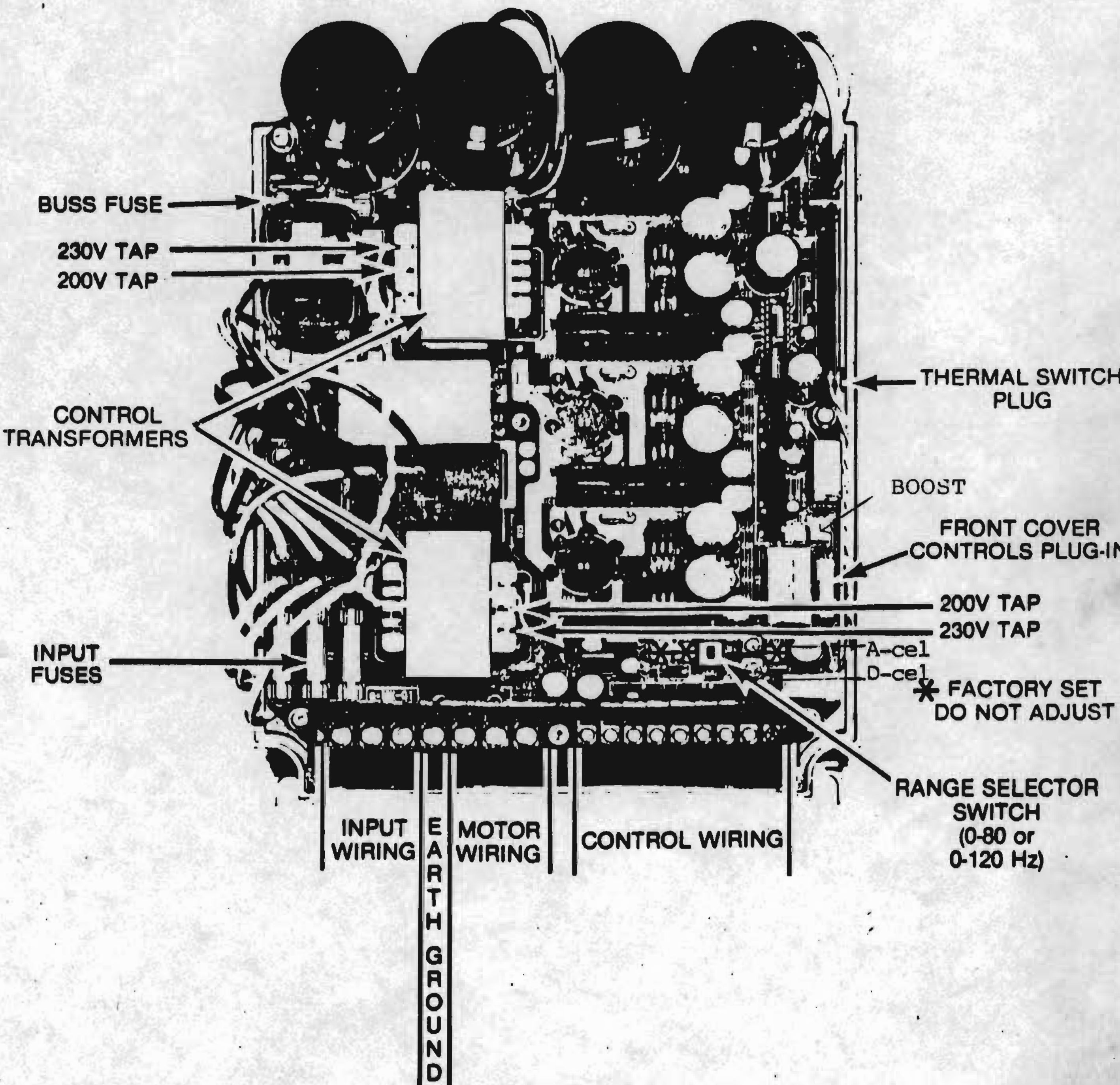


Fig. 14. PULSE SENSOR WIRING DIAGRAM

FIGURE 15

LOVEJOY WIRING DIAGRAM

USE EXTREME CAUTION WHEN MAKING ADJUSTMENT WITH POWER ON



Scale
Trouble Shooting

No Display

1. Disconnect power card. Check fuse.

2. Is power cord properly connected?

3. Turn power off. Wait 5 seconds and turn power on.

4. Disconnect power card. Check internal connections. CAUTION: Dis-power cord before performing this check.

   a. Remove platter.

   b. Back display cover away from scale carefully so as not to disconnect wiring.

   c. Check power, load cell, keyboard, and NOR-EXP wiring for loose connections.

Flashing Will Not Stop

1. Is the platter on straight? The gap between platter and display board should be even.

2. Remove all weight from platter.

3. Check for loose load cell connections. See #4 above.

Scale Will Not Tare

1. Are lock nuts tight?

2. Is scale level?

3. Is their air movement directed toward the scale?

4. Press the CLEAR key and then TARE.

Scale Does Not Repeat In Expanded Mode

If this occurs while weighing rods:

1. The rod adaptors should slide on and off and spin freely on the bearings. If they do not, sand out the ID.

2. Does the arm on the rod weighing device move freely?

3. Is the arm vertical with a rod in place?

4. Is the rod centered?

5. Is there air movement directed toward the scale?

6. Is the platter on straight? The gap between platter and display board should be even.

7. Are you putting the ring retaining groove down each time? If it occurs while weighing pistons:

   a. Accuracy to .1 of a percent is obtainable. A piston weighing 800 grams should repent to .8 gm. In most cases, the scale will exceed this.

   The accuracy of the scale can be checked with a known weight. A nickle weighs 5 grams. If the scale checks out with a known weight but is not repeating, look for other things, such as those listed above that may cause the problem.

SPARE PARTS

The Hines Hard Bearing unbalance Measuring System has been designed to keep spare parts requirements to a minimum. Feel free to contact our Service Dept. at 313-769-2300 anytime you encounter a problem.

Belts:	3/4 x 52"	$25.00
	3/4 x 56"	25.00
	3/4 x 60"	25.00
V-Blocks:	5/8" wide	36.00
	1" wide	36,00
Pulse Sensor Shaft		40.00
U-Joints:	Threaded	9.00
	Unthreaded	6.00
V-8 Bobweight Caps		6.00 each
V-8 Bobweight Cups		23.00 each
Nut Driver		6.00
Bobweight Cards		6.00/100
Promotion Cards		8.00/100
Dust Covers:	Analyzer	22.50
	Scale	22.50

HINES INDUSTRIES, INC.

661 Airport Blvd., Suite #2 / Ann Arbor, Mich. 48104 / (313) 769-2300

LIMITED WARRANTY

HINES INDUSTRIES, INC., the manufacturer, warrants that for a period of twelve (12) months from date of shipment, it will repair, or at its option replace, any new apparatus which proves defective in material or workmanship, or which does not conform to applicable drawing and specifications approved by the manufacturer. All repairs or replacements shall be F.O.B. factory. All claims must be made in writing to the manufacturer.

In no event and under no circumstances shall manufacturer be liable for (a) damages in shipment, (b) failures or damages due to misuse, abuse, improper installation, unauthorized modifications or abnormal conditions of temperature, dirt or corrosives, (c) failures due to operation, intentional or otherwise, above rated capacities, and (d) non-authorized expenses for removal, inspection, transportation, repair or rework. Nor shall manufacturer ever be liable for consequential and incidental damages, or in any amount greater than the purchase price of this apparatus. HINES shall not warrant "wear" parts.

Warranties on the following items are covered by the manufacturer: Motor speed control (Parametrics), drill press (Clausing or Wilton), scale (Grand Rapids Scale) and motors (Baldor Electric Motors).

This warranty is in lieu of all other warranties, express or implied, including (but not limited to) any implied warranties of merchantibility or fitness for a particular purpose. The terms of this warranty consitute any buyer's and/or user's sole and exclusive remedy, and are in lieu of any right to recover for negligence, breach of warranty, strict tort liability, or upon any other theory. Any legal proceedings arising out of the sale or use of this apparatus must be commenced within eighteen (18) months of the date of installation.

GOODS RETURNED FOR REPAIR - No goods will be accepted for repair unless there is prior written authorization by HINES. In all cases, transportation charges must be prepaid. Items sent collect will not be accepted. Items sent to customer will be sent "Freight Collect".

INTERPRETATION - There are no conditions or understandings whatsoever verbal or otherwise, except as written herein and this statement contains the complete and exclusive agreement between the manufacturer and buyer. No waiver, alterations or modification of any of the provisions hereof shall be binding upon the manufacturer unless made in writing and signed by a duly authorized officer of the manufacturer.

Rev. 6/86

Technical Bulletin

November 18, 1981

ALVIN P. BEAN, Executive Vice President

TB-82-3

1981 5.OL (302) ENGINE- FLYWHEEL, CRANKSHAFT AND DAMPER USAGE

It has come to our attention that some 1981 5.OL engines have 1980 crankshafts, flywheels and dampers installed. These engines are readily identified by a decal having a red "S" on a white background that is located on the left hand rocker cover. These engines are installed in 1981 Fords, Lincoln-Mercury and light trucks. The 1980 and 1981 5.OL crankshaft, flywheel and damper are balanced by different specifications and will not interchange.

The newly released 1981 5.OL crankshaft, flywheel and damper cannot be used on a 1980 engine unless all three components are installed simultaneously. Otherwise, a vibration problem will raise its ugly head.

To definitely identify the different year model of parts, the engineering part number of the crankshaft damper is stamped on the damper surface. The different year model numbers are listed below:

1980	1981
D20E-6316-A2A	EIAE-6316-A1A
D20E-6316-A3A	EIAE-6316-A2A
D8TE-6316-FA	EIAE-6316-A3A
D6ZE-6316-AA	EIAE-6316-B1A
EOAE-6316-D1A/B	EIAE-6316-B2A
EOAE-6316-D2A/B	EIAE-6316-B3A
EOAE-6316-D3A/B	EITE-6316-F1A
	EITE-6316-F2A
	EITE-6316-F3A

Use the following guideline when servicing a 1981 vehicle that have have a 1980 5.OL engine installed:

1. Look for the decal on the left rocker cover having a red "S" on a white background.
2. Check engineering part number at the crankshaft damper for year identification.
3. Replace the necessary component with a 1980 model if engine year can positively identified as a 1980 model. Crankshaft casting #2MAD - part number DQAZ-6303-A.
4. Replace the crankshaft, flywheel and damper as a set using 1981 model components if engine year cannot be identified. 1981 crankshaft cast #2MAE part number EIAZ-6303-A.

ENGINE REBUILDERS AUTOMOTIVE ASSOCIATION A.E.R.A.

www.cull.ca

SHOP PROCEDURE BULLETIN

1238 Waukegan Road
Glenview, Illinois 60025

SPB No. 83
Feb., 1982

ENGINE MASS BALANCE INVOLVING THE CRANKSHAFT PULLEY, DAMPER OR FLYWHEEL ON 1982 FORD PRODUCTS WITH 3.8L ENGINE

When working on the crankshaft pulley, damper or flywheel on the Ford 3.8L engine, the following procedure is recommended to maintain mass balance of the engine:

1. If the crankshaft pulley and vibration damper have to be separated, mark the damper and pulley so that they may be reassembled in the same relative position. This is important because the damper and pulley are initially balanced as a unit.

2. If the crankshaft damper is being replaced, check if the original damper has balance pins installed. If so, new balance pins (Part No. EOSZ-6A328-A) must be installed on the new damper in the same orientation as on the original damper. The crankshaft pulley, either new or original, must also be installed in the same relative position as originally installed.

3. If the flywheel is to be replaced, check if the original flywheel has balance pins or rivets installed. If so, new balance rivets (Part No. E2DZ-6A328-A or B for automatic transmissions) and balance pins (Part No. E2TZ-6A328-A or B for manual transmissions) must be installed on the new flywheel in the same orientation as on the original flywheel.

Note: The above procedures do NOT apply if the short block, the crankshaft or more than 3 pistons and connecting rods are replaced.

PART NUMBER	PART NAME *
EOSZ-6A328-A	Balance Pin - Damper
E2TZ-6A328-A	Balance Pin - Flywheel Manual Trans. (.21 Oz.)
E2TZ-6A328-B	Balance Pin - Flywheel Manual Trans. (.110 Oz.)
E2DZ-6A328-A	Balance Rivet - Flywheel Auto. Trans. (.25 Oz.)
E2DZ-6A328-B	Balance Rivet - Flywheel Auto. Trans. (.60 Oz.)

* The difference between the balance pins is the weight and length of the pins. The balance rivets have a difference in weight due to the thickness of the rivet head.

The Technical Committee

THE FOLLOWING PERCENTAGES ARE THOSE USED OR
RECOMMENDED BY THE ENGINE MANFUACTURER.

All three-throw V-6 crankshafts normally require 50% of the reciprocating weight plus 100% of the rotating weight to produce the proper weight quantity for each of 3 bobweights. Exceptions are engines such as GMC 53, 71, and 92 series.

BUICK -- 90 degrees V6, 3.2, 3.8, and 4.1 Litre require 36.6% of the reciprocating weight and 100% of the rotating weight for each of 6 bobweights. All engines are EXTERNALLY balanced. ***RACE 44% Recp.---100% Rotating.

FORD & CAPRI -- 60 degrees V6 Capri and Ford 2.8 Litre V6 require 50% of the reciprocating weight and 100% of the rotating weight for each of 6 bobweights. Both engines are INTERNALLY balanced.

-- 3.8 Litre V6 90 degree Split Pin crank require 39.4% reciprocating weight and 100% of the rotating weight for each of 6 bobweights. EXCEPT Truck and continental use. These require 39.4% reciprocating weight and 100% rotating weight, plus adding 3 oz-in at V-damper end of crank through center-line of counter-weight on V-damper. All engines are EXTERNALLY balanced.

GENERAL MOTORS -- 3.3 Litre, 3.8 (229 cu.in.) V6 designed by CHEVROLET require 46% of the reciprocating weight and 100% of the rotating weight for each of 6 bobweights. Both engines are INTERNALLY balanced.

GENERAL MOTORS -- 2.8 Litre 60 degree V6 require 50% of the reciprocating weight and 100% of the rotating weight for each of 6 bobweights. EXTERNALLY balanced on Flywheel end ONLY.

PERKINS 3 CYL GAS & DIESEL -- No reciprocating weight, 50% rotating weight on each of 3 bobweights

VOLVO, PEUGEOT, & RENAULT -- V6 require 50% of the reciprocating weight & 100% of the rotating weight for each of 6 bobweights.

4.3 LITER V-6 DIESEL OLDS (EVEN FIRE) & 100% rotating (takes 6 bobweights) 35.2% reciprocating weight

Above figures are based on manufacturer's specs. for passenger car use.

Some V6 type engines are EXTERNALLY balanced as noted above. To determine this, Examin the flywheel and vibration damper to determine if a counter-weight is present. It is important to examine the flywheel (flexplate) and vibration damper to be certain. Different combinations are sometimes produced that may vary the above.

To balance this type of engine, the flywheel and vibration damper must be installed on the crankshaft, as they would be assembled to the engine. This means the timing gear a any spacers must be assembled, to properly position the vibration damper in place. Remember, the above mentioned INTERNALLY or EXTERNALLY balanced engines may not always be as described, some variations may occur.
RACING APPLICATIONS: BALANCE PERCENTAGES MAY DIFFER FROM PASSENGER CAR SPEC'S.

EXTERNALLY BALANCED ENGINES

AMC
- V-8 290 1966 some
- V-8 All from 1967 forward

BUICK
- V-6 3.2 Litre
- V-6 3.8 Litre (231)
- V-6 4.1 Litre
- V-6 225

- V-8 401
- V-8 400
- V-8 455
- V-8 322
- V-8 340

CHEVROLET
- V-6 2.8 Litre Flywheel Only
- V-8 400 Small Block
- V-8 427 HD Truck Application
- V-8 454

- V-6 Truck 305C
- V-6 Truck 379
- V-6 Truck 432

CHRYSLER -- DODGE -- PLYMOUTH
- V-8 340 on Cast Iron Crankshaft
- V-8 360 on automatic transmission, counterweighting is on torque convertor. On standard transmission, counterweighting is on flywheel
- V-8 400 on Cast Iron Crankshaft only
- V-8 440 on Cast Iron Crankshaft only

FORD
- V-6 3.8 Litre 2 different V-damper Combinations
- V-8 221 OHV
- V-8 260
- V-8 289
- V-8 302
- V-8 330 HD
- V-8 351
- V-8 361
- V-8 391
- V-8 400
- V-8 410
- V-8 428
- V-8 460 1979 and Forward. On Flywheel and a separate counterweight on V-damper end
- V-8 475 Truck
- V-8 534 HD Truck

GMC
- V-6 305 Truck
- V-6 351 Truck
- V-6 401 Truck
- V-6 478 Truck

INTERNATIONAL
- V-8 304
- V-8 345
- V-8 392

JEEP
- V-6 225

MERCEDES

Some 6 cylinder - no balance is performe by the factory on crankshaft. All corrections are on Flywheel and V-damper

OLDSMOBILE
- V-8 350
- V-8 425
- V-8 455

PONTIAC
- V-8 326
- V-8 389 Most are heavily compensated on flywheel to overcome bad crankshaft balance
- V-8 400
- V-8 450
- V-8 455

Also, if crankshafts are cross-drilled for extra oiling, Ford recommends 15 grams additional for oil in crank-pin on bobweigh

4 grams when not cross drilled on bobweight

This should apply to all makes of crankshaf and this amount is in addition ~~to oil on~~ piston and rod.

19 grams

Early 2M 302 Ford Cranks to Late 2MAE Cut front C-W .800. Cut two rear C-W .850 Balance Weight 1860 - .930 oz.

*** The above noted engines may not always be as described. Some variations may occur.

HINES INDUSTRIES, INC.

661 Airport Blvd., Suite #2 / Ann Arbor, Mich. 48104 / (313) 769-2300

MAJOR COMPETITION DEPARTMENTS

The addresses and telephone numbers for the competition or high-performance departments of all the major manufacturers selling cars in the U. S. are listed below. Do not call or write these people for anything other than assistance with high-performance or competition related matters.

ALFA ROMEO
Technical assistance
250 Sylvan Avenue
Englewood Cliffs, NJ 07632
(201 871-1234

AMC
Parts, technical assistance
Jim Radner, Manager,
Performance Activities
27777 Franklin Road
Southfield, MI 48034
(313) 827-3839

BMW
Technical assistance
Jim Patterson
BMW of North America
Montvale, NJ 07645
(201) 573-2179

CHRYSLER
Parts, technical assistance
Service & Parts
(includes "Direct Connection")
2631 Lawrence, P. O. Box 1718
Centerline, MI 48288
(313) 497-1000

DATSUN
Parts, technical assistance
Datsun Competition Dept.
P. O. Box 191
Gardena, CA 90247
(213) 538-2610

FORD
Parts, technical assistance
(informal program only)
Special Vehicle Operations
20800 Oakwood Blvd.
Dearborn, MI 48121
(313) 594-2930

GENERAL MOTORS
All performance parts handled through dealers only
Technical assistance

CHEVROLET
Chevrolet Product Promotion
Chevrolet Engineering Center
Attn: Vince Piggens
30003 Van Dyke
Warren, MI 48090
(mail inquiries only)

BUICK
Engineering Department
Attn: Mr. Joe Negri
902 Hamilton
Flint, MI 48552
(313) 236-5000

FIAT/LANCIA/FERRARI
Parts, technical assistance
(Fiat & Lancia only)
PBS Engineering
11682 Anabel
Garden Grove, CA 92643
(714) 534-6700

HINES INDUSTRIES, INC.

HINES

661 Airport Blvd., Suite #2 / Ann Arbor, Mich. 48104 / (313) 769-2300

Motorcycle Bobweights

SINGLE CYLINDER	(BSA, TRIUMPH, AJS, MATCHLESS, YAMAHA) 61% RECIPROCATING WEIGHT -- 100% ROTATING
VERTICAL TWINS	(BSA, TRIUMPH, NORTON) 60% to 70% RECIP. WT. -- 100% ROTATING (50% RACE RECIP. WT.)
OPPOSED TWIN	(BMW) 60% STREET RECIP. WT. -- 100% ROTATING (50% RACE RECIP. WT.)
V-TWIN (75°)	(YAMAHA) 55% to 60% RECIP. WT. -- 100% ROTATING (STREET) 60% to 65% RECIP. WT. -- 100% ROTATING (RACE)
V-TWINS	(HARLEY-DAVIDSON, INDIAN) 52% RECIP. WT. -- 100% ROTATING *
V-FOUR	(HONDA) 50% RECIP. WT. -- 100% ROTATING
3-CYLINDER	(BSA, TRIUMPH, YAMAHA) 50% RECIP. WT. -- 100% ROTATING
4-CYLINDER	(HONDA, KAWASAKI, SUZUKI, YAMAHA) SYMMETRICAL -- NO BOBWEIGHTS
6-CYLINDER	(HONDA, KAWASAKI, BENELLI) SUMMETRICAL -- NO BOBWEIGHTS

REFERENCE NOTE: 1982 YAMAHA XZ550 (70°) V-TWIN HAS GEAR DRIVEN BALANCERS.

NOTE: THESE PERCENTAGES HAVE NOT BEEN PROVEN BY HINES INDUSTRIES.
***** ***

They do vary according to the speed at which they will be running and the bike's gearing.

*See next page

HINES

HINES INDUSTRIES, INC.

661 Airport Blvd., Suite #2 / Ann Arbor, Mich. 48104 / (313) 769-2300

Harley Davidson Bobweight

Rotating Wt.

- Rod rotating ______________
- Rod rotating ______________
- Bearings & cages ______________ Total ______________

Reciprocating Wt.

- 2 Pistons ______________
- 4 Locks ______________
- Reciprocating ______________
- Reciprocating ______________ x ____%* ______________

Bobweight required ____________

*Low speed	52%
3-4000 rpm	57%
Race engines	66%

WEIGHT of MATERIAL from DRILLED HOLES

in Steel and Brass (grams)
- for Aluminum Divide by 3
28.35 grams = 1 ounce

HOLE DEPTH			DIAMETER OF DRILL												
16ths	32nds	Inches	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
2	4	1/8	0.8	1.2	1.8	2.4	3.1	3.9	4.9	5.9	7.1	8.2	9.6	11.0	12.6
3	6	3/16	1.2	1.8	2.6	3.6	4.7	5.9	7.3	8.9	10.6	12.4	14.4	16.5	18.8
4	8	1/4	1.6	2.5	3.5	4.8	6.3	7.8	9.8	11.8	14.1	16.5	19.2	22	25
5	10	5/16	2.0	3.1	4.4	6.3	7.8	9.8	12.2	14.8	17.6	21	24	28	31
6	12	3/8	2.4	3.7	5.3	7.2	9.4	11.8	14.7	17.8	21	25	29	33	38
7	14	7/16	2.7	4.3	6.2	8.4	11.0	13.7	17.2	21	25	29	34	39	44
8	16	1/2	3.1	4.9	7.0	9.6	12.5	15.7	19.6	24	28	33	38	44	50
9	18	9/16	3.5	5.5	7.9	10.8	14.1	17.7	22	27	32	37	43	50	56
10	20	5/8	3.9	6.1	8.8	12.0	15.7	19.6	24	30	35	41	48	55	63
11	22	11/16	4.3	6.7	9.7	13.2	17.2	22	27	33	39	46	53	61	69
12	24	3/4	4.7	7.3	10.6	14.4	18.8	23	29	36	42	50	58	66	75
13	26	13/16	5.1	7.9	11.5	15.6	20	25	32	38	46	54	62	72	81
14	28	7/8	5.5	8.6	12.3	16.8	22	27	34	41	49	58	67	77	88
15	30	15/16	5.9	9.2	13.2	18.0	24	29	37	44	53	62	72	83	84
16	32	1	6.3	10.0	14.4	19.2	25	32	39	47	56	66	77	88	100
Add this weight for point of drill			0.1	0.2	0.4	0.6	0.9	1.3	1.8	2.4	3.1	3.9	4.8	6.0	7.2