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GRAY/LAHR DEEP HOLE DRILLING MACHINE

ALIGNMENT AND ACCURACY CHECKS

Customer: Heavy Electricals, Ltd.
Bhopal, India

Machine Serial Number: 9791

Machine Model Number: 0682SDR2

The G. A. Gray Company
Cincinnati, Ohio 45207

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Preliminary

1. Machine environment must remain constant within practical limits during checks.
2. Once a particular check has been started, it must not be interrupted.
3. All indicators must be .0001" graduation and inspected for proper working order.
4. Before a check can be finalized, the indicator must repeat at reference zero.

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

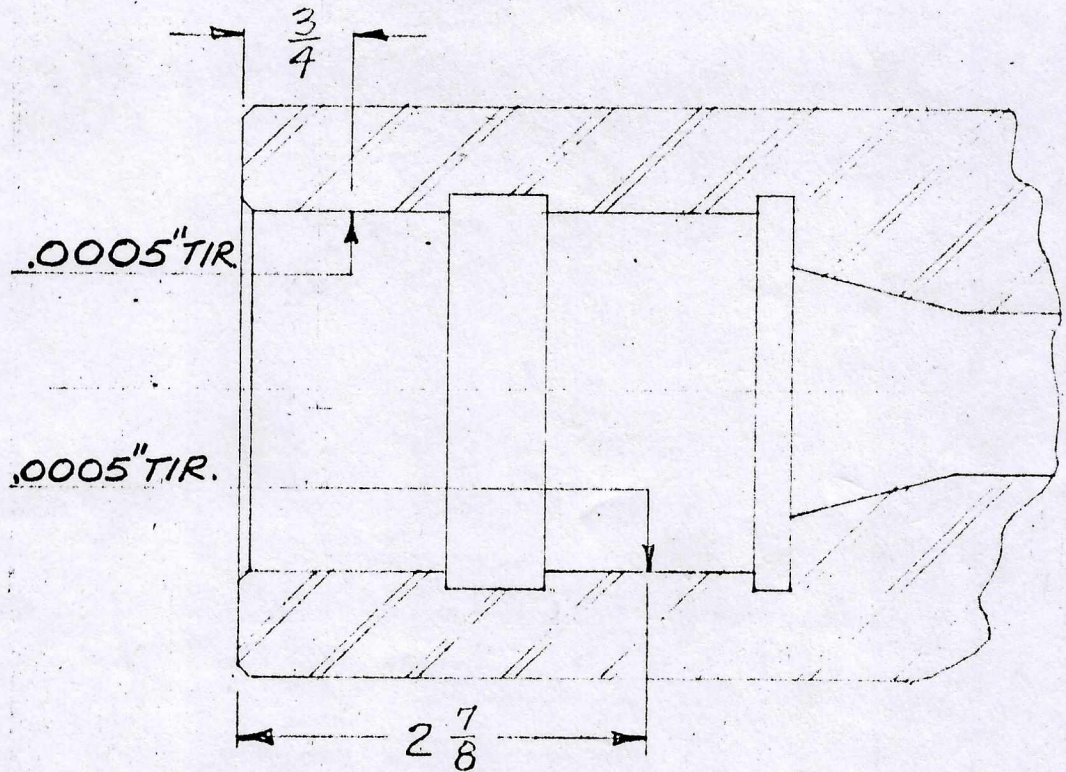
By _____

App'd. _____

I Spindles

A. Spindle bore runout

1. The purpose of this check is to determine the axial runout of the spindle bore.
2. Test conditions:
 - a. The spindle motors should be running for two (2) hours at 3000 r.p.m. to seat the bearings before any spindle checks are performed.
 - b. .0001" indicator with a magnetic base.
3. Procedure:
 - a. Place the indicator base on the z axis hardened way and zero on the spindle bore 3/4" in from the end.



- b. Rotate the spindle and record the reading.
- c. Move the indicator in 2-7/8" from the end zero and repeat Step b.

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date

By

App'd.

I. Spindles - Continued

A. Spindle bore runout - Cont'd.

d. Check each spindle.

e. Results:

Readings

Spindle	TIR @ 3/4"	TIR @ 2-7/8"
#1 Top	.0005"	.0003"
#2 Bottom	.0003"	.0001"
#3		

f. Deviation not to exceed .0005" TIR.

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

App'd. _____

I Spindles - Continued

B. Runout

1. The purpose of this check is to determine axial runout of each spindle.
2. Test conditions:
 - a. Indicators to be .0001" graduation and have a large button contact area.
 - b. Test bar #L-154A-36 (Lahr number).
3. Procedure:
 - a. Clamp the bar in spindle.
 - b. Place the magnetic indicator base on the z axis hardened way and zero the indicator on the test bar 10" from spindle nose.

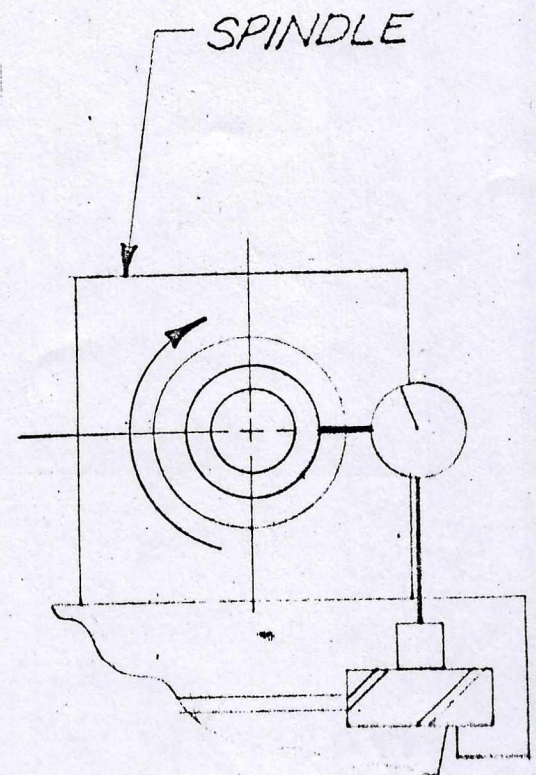
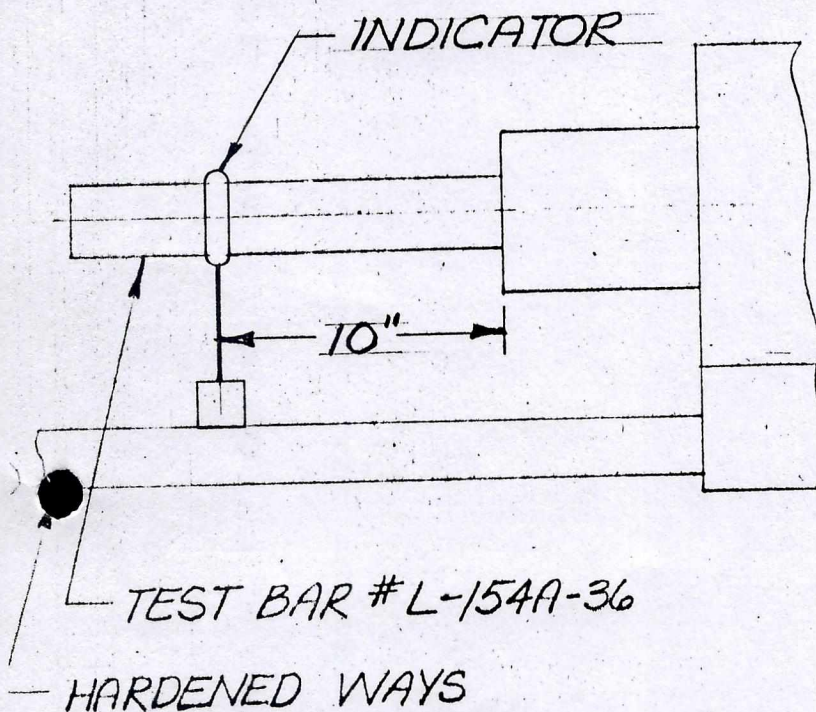


FIG. 2

- c. Rotate the spindle and record the TIR.
- d. The TIR must not exceed .002".

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

App'd. _____

I Spindles - Continued**B. Runout - Cont'd.****e. Check each spindle.****F. Results:**

Top - #1 Spindle	-	TIR <u>.0012"</u>
Bottom - #2 Spindle	-	TIR <u>.0017"</u>
#3 Spindle	-	TIR <u> </u>

C. Spindle Parallelism

1. The purpose of this check is to determine the spindle parallelism in two planes with the z axis ways.
2. Test conditions:
 - a. Indicators to be .0001" graduation and have a large button contact area.
 - b. Test bar #L-154A-36 (Lahr number).
3. Procedure:
 - a. The bar is clamped in the spindle as before.
 - b. Place the magnetic indicator base on the way and zero the indicator on the test bar, in the horizontal plane, 1" from the spindle nose.
 - c. Retract the spindle carriage 12" and record the indicator reading.
 - d. Repeat with the indicator zeroed on the bar in the vertical plane.

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

App'd. _____

I Spindles - Continued

C. Spindle Parallelism - Cont'd.

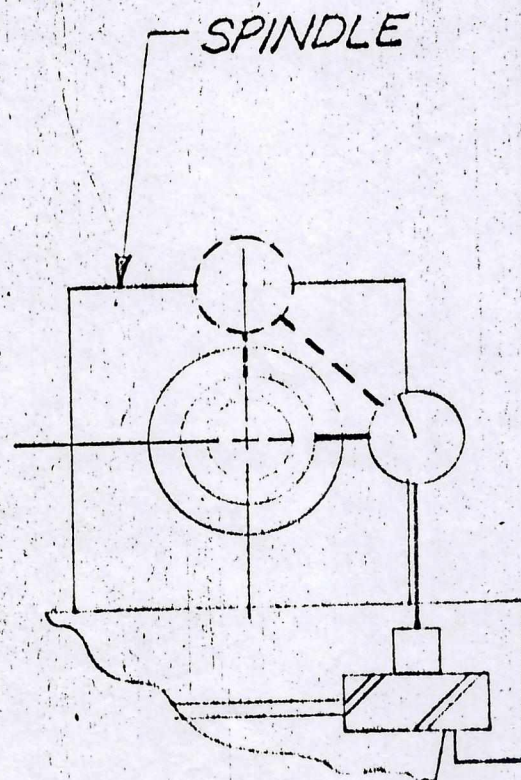
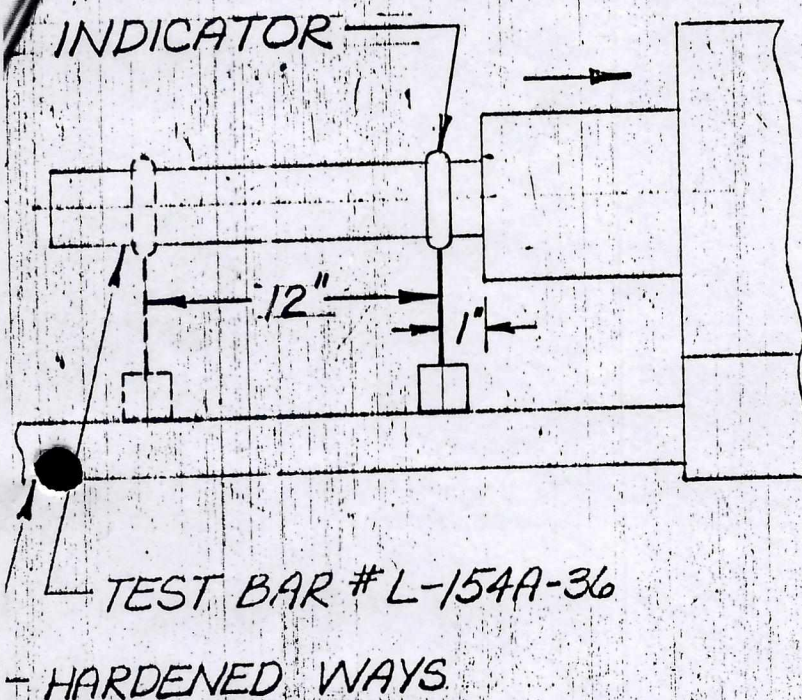


FIG. 3

- e. The TIR must not exceed .0005" in either plane.
- f. Check each spindle.
- g. Results:

Spindle	TIR	
	Horizontal Plane	Vertical Plane
#1	.000"	.000"
#2	-.0005"	.000"
#3		

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

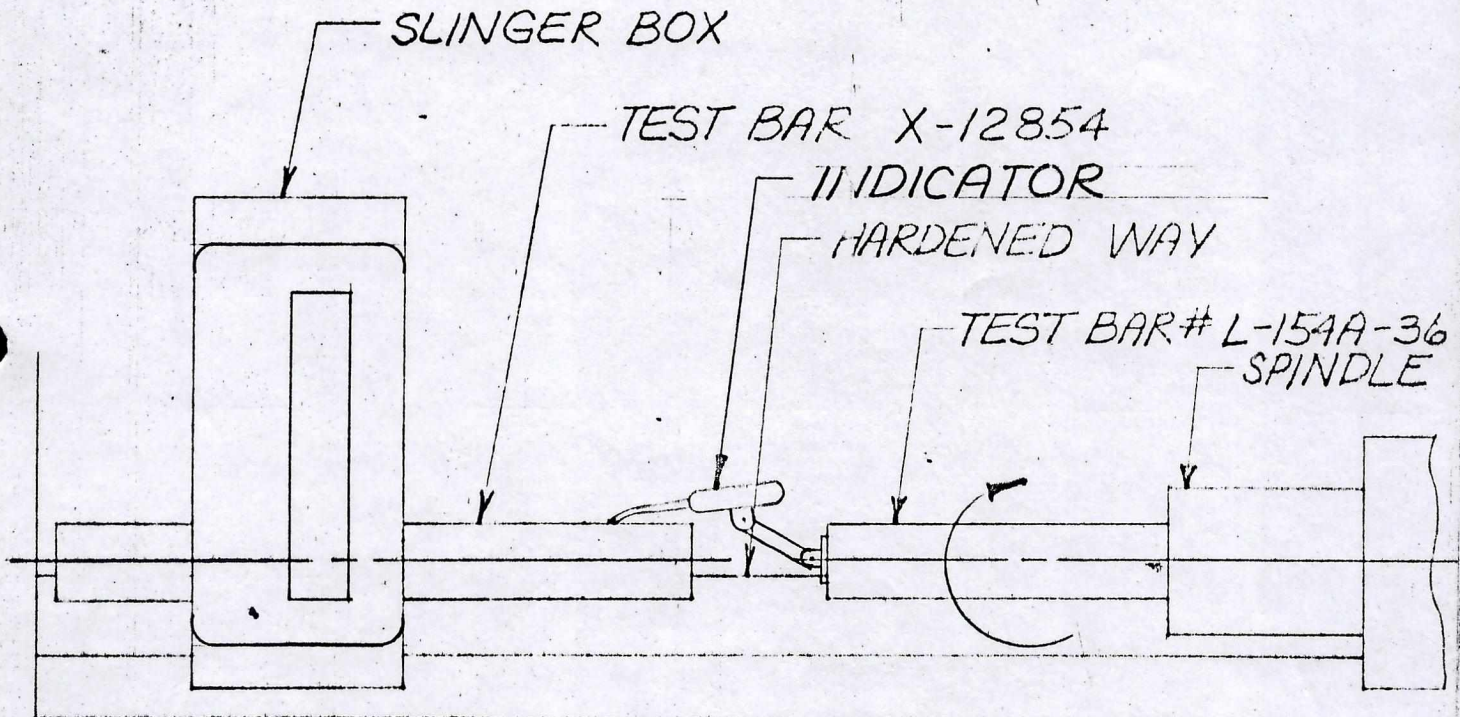
App'd. _____

II Bushing Carriage

A. Bushing bore runout

1. The purpose of this check is to determine the bushing bore alignment with the centerline of the spindle.
2. Test conditions:
 - a. Indicators to be .0001" graduation and have a large button contact area. (Same as in previous tests).
 - b. Test bar #X-12854.
3. Procedure:
 - a. Position bar X-12854 in bushing bore.
 - b. Place indicator on test bar #L-154A-36 and zero the indicator on the test bar #X-12854.
 - c. Rotate spindle and record the TIR.

FIG. 4



- d. Check each spindle.

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

App'd. _____

II Bushing Carriage - Continued

A. Bushing Bore runout - Cont'd.

e. Results:

#1 Spindle - TIR .0007"

#2 Spindle - TIR .0013"

#3 Spindle - TIR

f. Deviations not to exceed .0015".

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

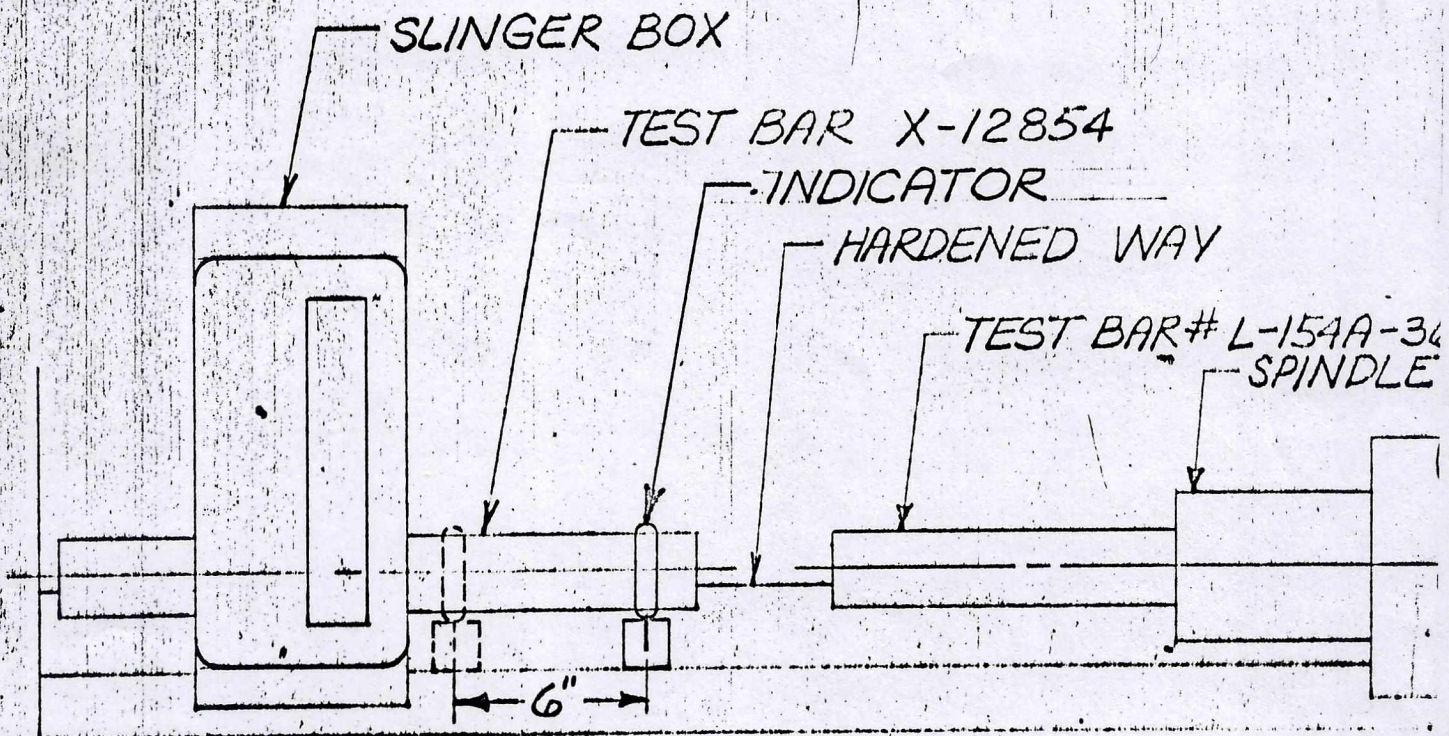
App'd. _____

II Bushing Carriage - Continued

B. Bushing parallelism

1. The purpose of this check is to determine the parallelism of the bushing bore to the hardened ways.
2. Test conditions:
 - a. Indicators to be .0001" graduation and have a large button contact area.
 - b. Test bar #X-12854.
3. Procedure:
 - a. Position bar #X-12854 in bushing bore.
 - b. Place magnetic indicator base on hardened ways and zero the indicator on the test bar in the horizontal plane.
 - c. Stroke bushing carriage 6" and record the reading.
 - d. TIR to be no greater than .0003".
 - e. Zero the indicator in the vertical plane and repeat part "c",

FIG. 5



Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date

By

App'd.

II Bushing Carriage - Continued

B. Bushing parallelism - Cont'd.

f. Results for each spindle:

TIR

Spindle	Horizontal Plane	Vertical Plane
#1	+.0002"	-.0003"
#2	-.001"	+.0003"
#3		

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

App'd. _____

III Runway

A. Vertical alignment (x-y plane)

1. The purpose of this check is to determine the deviation of the head in the vertical plane (x-y plane)
2. Test conditions:
 - a. The machine must be reasonably isolated from drafts, sunlight and other ambient effects that will influence the accuracy of the alignment checks.
 - b. This test will ordinarily be made only in final installation; factory test may be inconclusive because of temporary mounting and variable floor characteristics.
 - c. An optical level, or equivalent, is used with a scale or a target.
 - d. All measurements are to be made with the machine moving at a constant rate.
3. Procedure:
 - a. Level the instrument.
 - b. With a magnetic base, mount the scale or target vertically to the head.

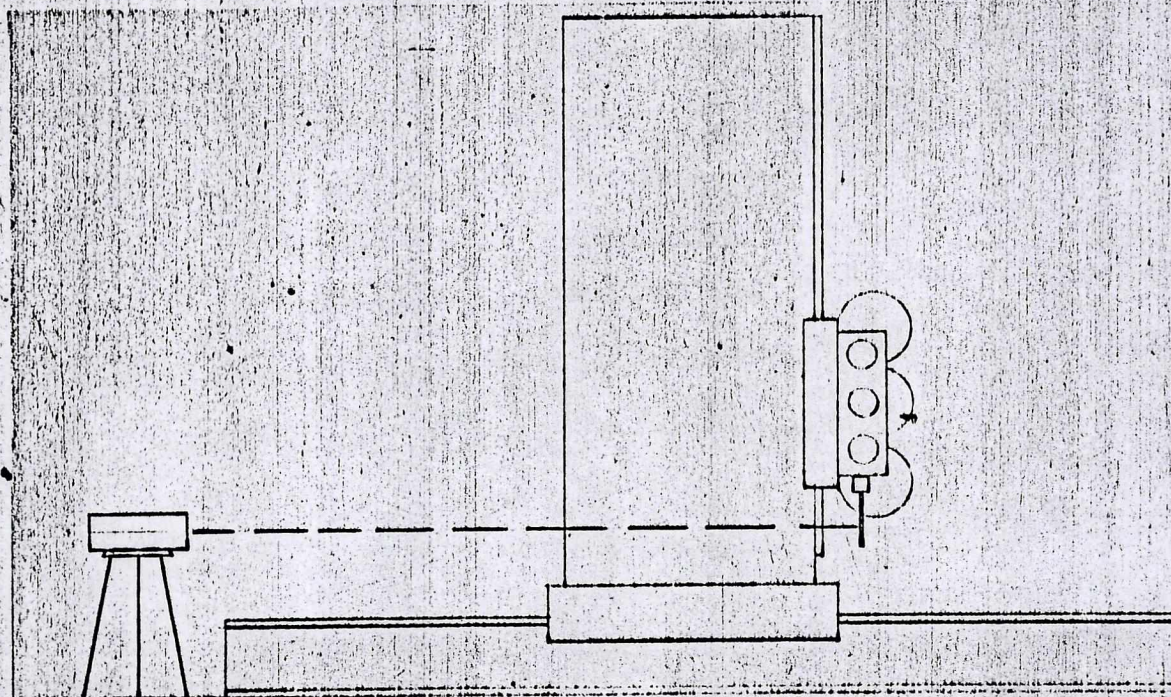


FIG 6

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

III Runway - Continued

App'd. _____

A. Vertical alignment - Cont'd.

- c. Begin with the column at the extreme travel (either end).
- d. Record the readings every foot and plot vs. travel:

Initial reading _____

<u>Travel</u>	<u>Reading</u>
0.0	0.0
12"	-1.6
24"	-3.2
36"	-4.2
48"	-4.8
60"	-5.4
72"	-5.8
84"	-6.9
96"	-7.8
0.0	- .0002
_____	_____
_____	_____

Repeat
Zero

- e. Deviation must not exceed .0005" in any foot; total deviation must not exceed .0005" + .00025" length of travel (feet).

Deep Hole Drilling Machine Alignment and Accuracy Checks

Date _____

By _____

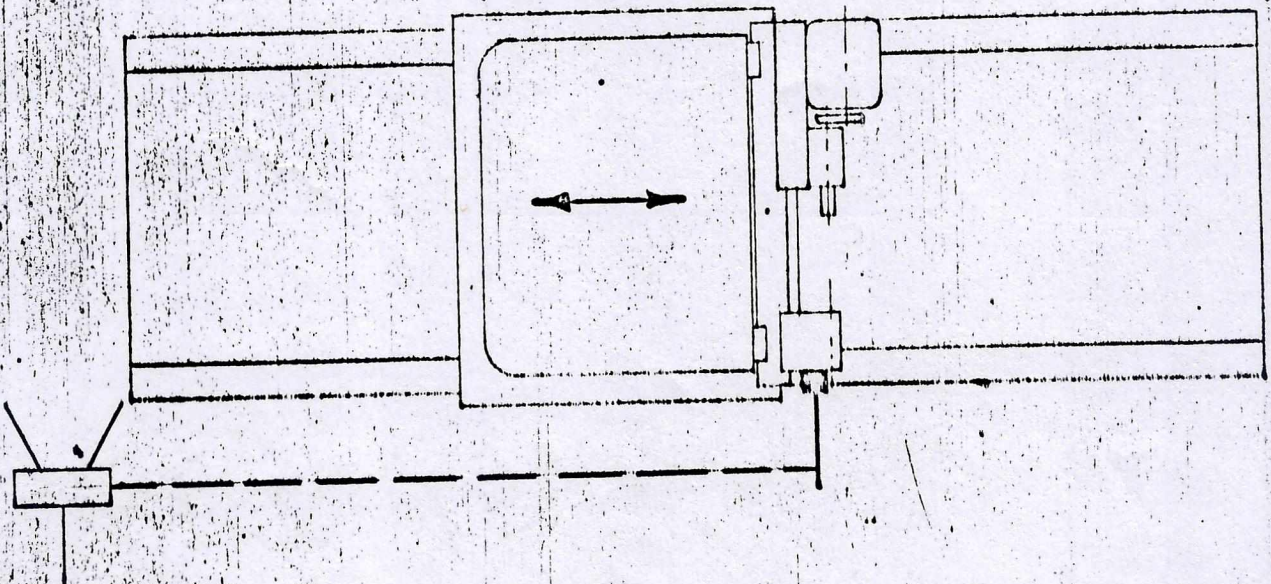
App'd. _____

III Runway - Continued

B. Horizontal alignment (x-z plane)

1. The purpose of this check is to determine the deviation of the head in the horizontal plane (x-z plane).
2. Test conditions:
 - a. The machine must be reasonably isolated from drafts, sunlight and other ambient effects that will influence the accuracy of the alignment checks.
 - b. This test will ordinarily be made only in final installation; factory test may be inconclusive because of temporary mounting and variable floor characteristics.
 - c. An optical level or equivalent is used with a scale or a target.
 - d. All measurements are to be made with the machine moving at a constant rate.
3. Procedure:
 - a. With the instrument level as before, mount the scale or target horizontally on the head.

FIG. 7
PLAN VIEW



- b. Begin with the column at the extreme travel (either end).

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date

By

App'd.

III Runway - Continued

B. Horizontal alignment - Cont'd.

- c. Record the readings every foot and plot vs. travel:

Initial reading _____

<u>Travel</u>	<u>Reading</u>
0.0	0.0
12"	- .0004
24"	- .0008
36"	- .001
48"	- .001
60"	- .0008
72"	- .0008
84"	- .001
96"	- .0015
Repeat Zero	0.0
	- .0001

4. Deviation must not exceed .001" in any foot;
total deviation not to exceed .001" + .0005"
x length of travel (feet).

- 15 -

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

App'd. _____

IV Column

A. Transverse plane (y-z plane)

1. The purpose of this check is to determine the deviation of the head in the transverse plane (y-z plane).
2. Test conditions:
 - a. The machine must be reasonably isolated from drafts, sunlight and other ambient effects that will influence the accuracy of the alignment checks.
 - b. This test will ordinarily be made only in final installation; factory tests may be inconclusive because of temporary mounting and variable floor characteristics.
 - c. A precision square is used in conjunction with a .0001" indicator with a magnetic base.
 - d. All measurements are to be made with the machine moving at a constant rate.
3. Procedures:
 - a. Level the 50" granite square.
 - b. Mount the indicator and base to the head.

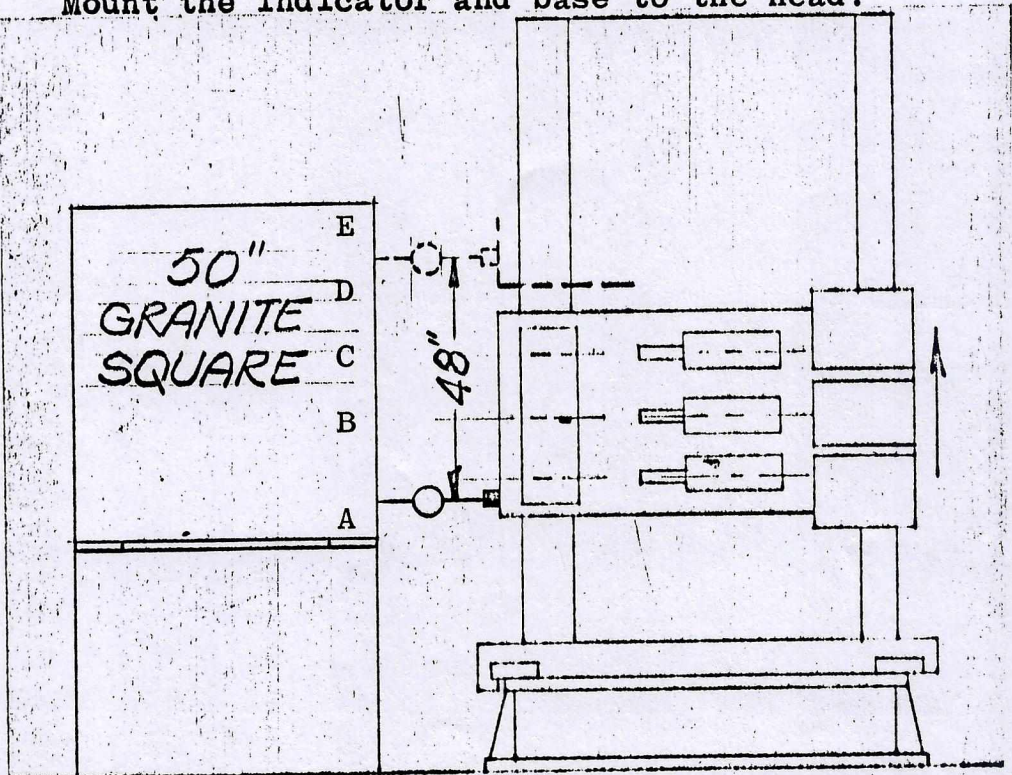


FIG. 8

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

App'd. _____

IV Column - Continued

A. Transverse plane - Cont'd.

- c. Zero the indicator on the face of the square and move the head 48" and record the reading:

Reading 0.0000"

- d. Deviation not to exceed .0005" in any foot:
total deviation not to exceed .0005" + .00025"
x length of travel (feet).

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date

By

App'd.

IV Column - Continued

B. Longitudinal plane - Cont'd.

- c. Zero the indicator on the face of the square and move the head 48 inches and record the reading:

Reading -.0002"

- d. Deviation not to exceed .0005" in any foot; total deviation not to exceed .0005" + .00025" x length (feet).

Deep Hole Drilling Machine Alignment
and Accuracy Checks

D.H. 0111

Date

By

App'd.

V Spindle Centerlines to Column Ways

A. The purpose of this check is to determine parallelism of the spindle centerlines with the column way surface.

B. (Test conditions:

1. Level the granite square as before. (This check may be performed in conjunction with part IV-B).
2. Zero the .0001" indicator on the spindle nose of the stationary spindle and slide the indicator to the spindle nose of the adjustable spindle (s). Record the readings:

Reading-#1 Spindle .000"

Reading #2 Spindle + .0005"

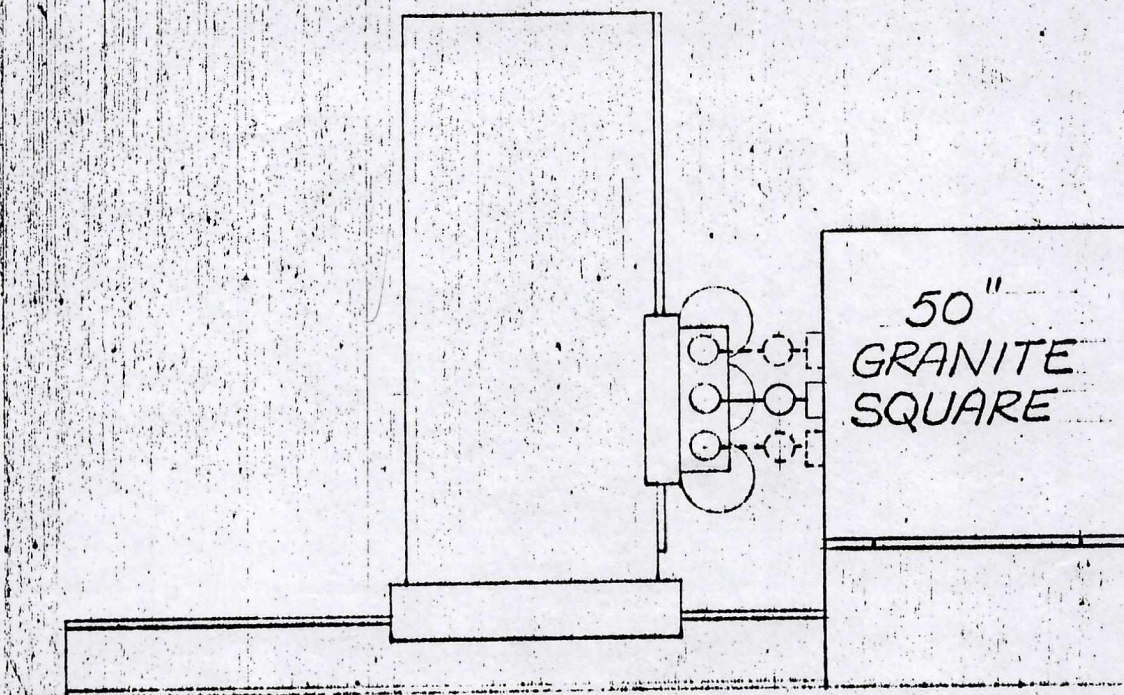


FIG. 10

3. Deviation not to exceed .001" between any two (2) spindles.

-20-

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

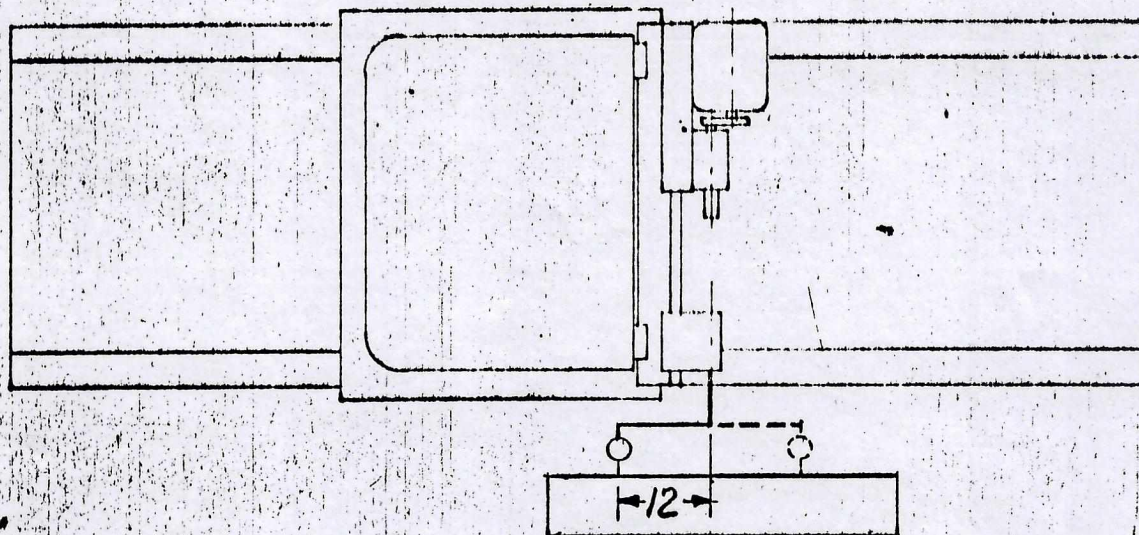
App'd. _____

VI Head Tram

- A. The purpose of this check is to determine the squareness of the z axis (spindle axis) with the x and y axes (horizontal and vertical axes, respectively).
- B. Test conditions:
1. 12" tram bar.
 2. 50" granite square.
 3. .0001" indicator.
- C. Procedure:
1. Place the tram bar in the stationary spindle.
 2. Attach the indicator to the tram bar.
 3. Traverse the column along the x axis until the indicator reads zero at both ends of the square.
 4. Tram the head with the x axis and record the reading:

Reading -.00025"

FIG. 11
PLAN VIEW



Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

App'd. _____

VI Head Tram - Continued

C. Procedure - Cont'd.

5. Next traverse the head along the y axis until the indicator reads zero at both ends of the square.
6. Tram the head with the y-axis and record the reading:

Reading .0007" - Bottom Spindle

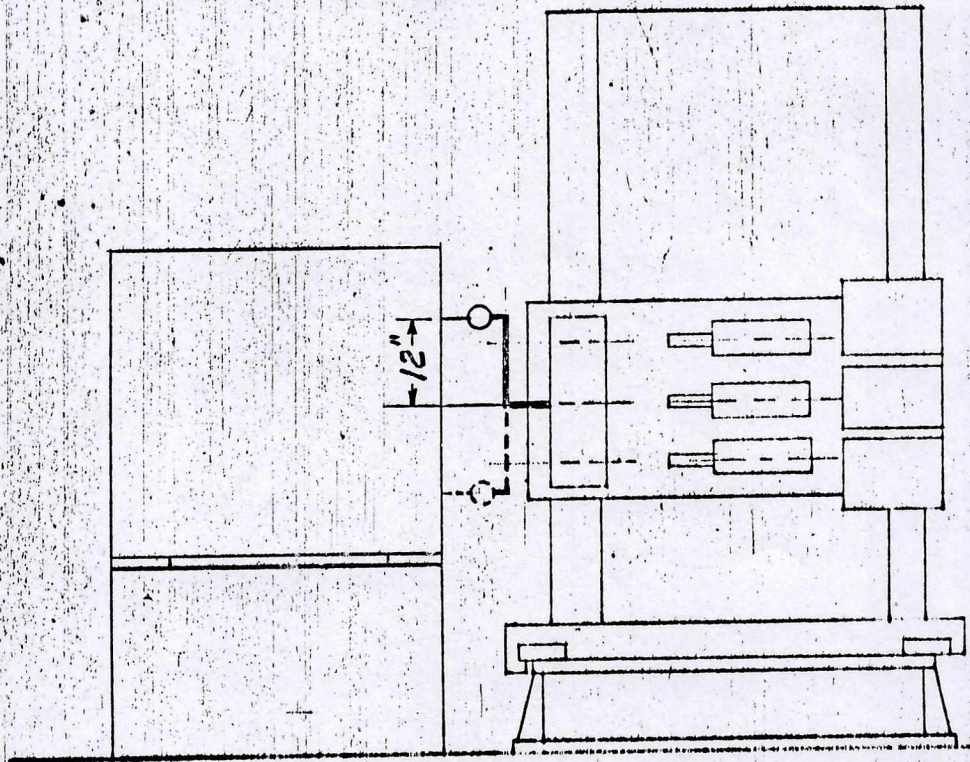


FIG. 12

7. Deviation should not exceed .001" in 24".

Deep Hole Drilling Machine Alignment and Accuracy Checks

Date _____

By _____

Positioning Accuracy Checks

App'd. _____

I. Runway (Column Positioning)

A. The purpose of this check is to determine the accuracy of column positioning (x axis travel).

B. Test conditions:

1. Laser interferometer and target.
2. The laser interferometer will be used at the Gray factory only. If field checks are required, a calibrated peg bar or equivalent will be used. Increments of positioning must be at the spacing of the pegs.

C. Procedure:

1. Using the test tape to position the machine according to the following random numbers, record the laser readings:

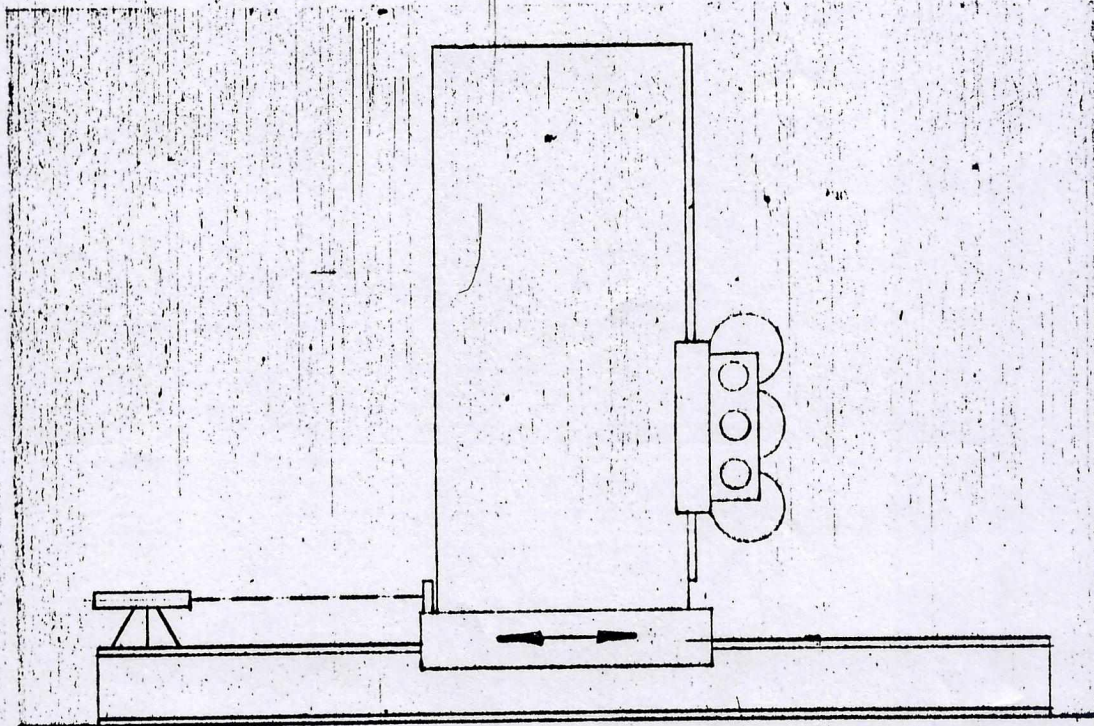


FIG. 13

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date

By

Positioning Accuracy Checks

App'd.

I Runway (Column Positioning) - Continued

C. Procedure - Cont'd.

<u>Machine Position</u>		<u>Laser</u>	<u>Difference</u>
0.000 in.	0000.00 mm	0.000	0.000
2.291 in.	0058.20 mm	<u>58.203</u> mm	<u>.003</u> mm
11.573 in.	0293.96 mm	<u>23.983</u> mm	<u>.023</u> mm
19.039 in.	0483.60 mm	<u>483.610</u> mm	<u>.010</u> mm
20.635 in.	0524.13 mm	<u>524.157</u> mm	<u>.027</u> mm
27.568 in.	0700.22 mm	<u>700.246</u> mm	<u>.026</u> mm
28.384 in.	0720.96 mm	<u>720.998</u> mm	<u>.038</u> mm
29.283 in.	0743.80 mm	<u>743.828</u> mm	<u>.028</u> mm
36.030 in.	0915.17 mm	<u>915.189</u> mm	<u>.019</u> mm
41.260 in.	1048.01 mm	<u>1048.029</u> mm	<u>.019</u> mm
6 ft.trav. 46.521 in.	1181.64 mm	<u>1181.666</u> mm	<u>.026</u> mm
8 ft.trav. 88.692 in.	2252.79 mm	<u>2252.840</u> mm	<u>.050</u> mm
10 ft.trav. 114.581 in.	2910.36 mm	_____	_____
12 ft.trav. 142.226 in.	3612.54 mm	_____	_____
154.979 in.	3936.48 mm	_____	_____
163.078 in.	4142.20 mm	_____	_____
14 ft.trav. 165.142 in.	4194.62 mm	_____	_____
return to 0.00 in.	0.00 mm	<u>.003</u> mm	<u>.003</u> mm

Must return to 0.000 within .001"

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date

By

App'd.

Positioning Accuracy Checks

I Runway (Column Positioning) - Continued

C. Procedure - Cont'd.

2. Plot the difference vs. machine position.
3. Deviation not to exceed .0005" in any foot; total deviation not to exceed .0005" + .00025" x travel (feet).

Deep Hole Drilling Machine Alignment
and Accuracy Checks

Date _____

By _____

Positioning Accuracy Checks

App'd. _____

II Column (Head Positioning)

- A. The purpose of this check is to determine the accuracy of head positioning (y axis travel).
- B. Test conditions:
1. Laser interferometer and target.
 2. The laser interferometer will be used at the Gray factory only. If field checks are required, a calibrated peg bar or equivalent will be used. Increments of positioning must be at the spacing of the pegs.
- C. Procedure:
1. Using the test tape to position the machine according to the following random numbers, record the laser readings:

