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<td>FA ltr, 8 May 1954; ARRADCOM ltr, 19 Nov 1979</td>
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TECHNICAL MEMORANDUM
553-22-1

EXAMINATION AND EVALUATION OF
CANADIAN AIMING CIRCLE
BY W. W. HOLLIS

Fire Control Instrument Group
FRANKFORD ARSENAL
PHILADELPHIA, PA.

23 MAY 1953

SECURITY INFORMATION
EXAMINATION AND EVALUATION OF CANADIAN AIMING CIRCLE

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Chief, RAD Division
Ground Weapons Department

WWHollis/14/715
23 May 1953

Approved by: ALAN E. GEE
Lt Col, Ord Corps
Chief, Ground Weapons Dept

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SECURITY INFORMATION
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EXAMINATION AND EVALUATION
OF
CANADIAN AIMING CIRCLE

I. AUTHORITY

This report is prepared under authority contained in letter file O0 413.68/565, Subject: Canadian Aiming Circle, dated 14 November 1952 and is a part of Ordnance Project TR5-5009.

II. INTRODUCTION

1. The Optical Design Branch, R&D Division, Ground Weapons Department, FCM has been assigned the responsibility for the study and evaluation of the Canadian Director, Artillery No. 7, Mk 4. This report is the result of that study.

2. An attempt has been made to discuss the desirable and objectionable features of the Canadian Instrument and to compare it with the standard Aiming Circle M1. In areas where the Aiming Circle T3 differs in essential features from the M1, comparison of the Canadian Aiming Circle has been made with the Aiming Circle T3 as well.

3. The figures included in this report are copies of those found in Canadian Army Local E.M.E. instructions entitled, Directors No. 7, Description and Theory.

III. DISCUSSION

1. The base of the instrument (fig. 3) is drilled and tapped to accommodate the clamping screw of the stand or tribrach and is also provided with three \( \sqrt{3} \) shaped grooves spaced approximately 120° apart which fit over the positioning studs on the stand.

2. The lower motion, controlled by a worm and wheel, is provided with a quick release lever which disengages the slow motion spindle and allows the instrument to slew rapidly in azimuth. (Figure 4)

3. The azimuth scale (fig. 5) is pivoted on the base. The scale is graduated every degree and numbered every ten degrees from 0 to 350.
4. The body of the instrument pivots about the azimuth scale and is provided with two index marks 180° apart for reading the azimuth scale. One of these marks, located under the eyepiece of the telescope, is black; the other, located under the objective, is red. The upper motion of the instrument is controlled by a worm and wheel (fig. 7). Fine motion is provided by means of a micrometer drum graduated every two minutes and numbered every ten minutes. The upper motion is provided with a throw out mechanism for slewing. One complete revolution of the spindle moves the director through 2°. The compass needle is viewed through a plane window. The compass is adjustable to compensate for varying magnetic declination. The needle may be lifted from its pivot, when the compass is not in use, by means of a spring loaded plunger.

5. The telescope (fig. 9) open sight, level bubble and elevating mechanism are carried on trunnions which are part of the body. The telescope is 4.5 power with a field of view of 12°. The eyepiece is inclined at an angle of 50 degrees with the line of sight of the objective. Elevation is provided from plus 65 degrees to minus 15 degrees. The telescope is provided with an eye shield, weather shield and a neutral filter. The reticle is divided into four quadrants by two cross lines and the axes are graduated in degrees from 0 to 6 degrees in each direction and subdivided into ten minute increments. The elevating gear is operated by means of a spindle fitted on one end with a micromotor drum which is read against an adjustable index. The elevation scale is graduated from 15 degrees depression to 65 degrees elevation. One turn of the spindle is equivalent to 5 degrees. The micrometer is numbered every degree, black for elevation, red for depression.

6. The following table shows a comparison of the main physical characteristics of the Canadian Instrument and the Aiming Circle M1.
<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>ML Diameter</th>
<th>Canadian Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diameter</td>
<td>5 inches appr.</td>
<td>5.5 - 6 inches appr.</td>
</tr>
<tr>
<td>2</td>
<td>Height</td>
<td>4.25 inches</td>
<td>9.5 inches appr.</td>
</tr>
<tr>
<td>3</td>
<td>Weight</td>
<td>4 pounds</td>
<td>5.6 pounds</td>
</tr>
<tr>
<td>4</td>
<td>Scaling *</td>
<td>Yes (modified ML)</td>
<td>Yes (Partially)</td>
</tr>
<tr>
<td></td>
<td>a. Telescope</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Mechanical Assembly</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Winterized</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Leveling *</td>
<td>Ball &amp; Socket on tripod</td>
<td>Three point leveling of instrument</td>
</tr>
<tr>
<td>7</td>
<td>Sighting Aid *</td>
<td>4x Telescope</td>
<td>4.5x Telescope with inclined eyepiece</td>
</tr>
<tr>
<td>8</td>
<td>Compass *</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Leveling Indicator</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Azimuth Scale</td>
<td>0-6400' (external)</td>
<td>0-360° (external)</td>
</tr>
<tr>
<td>11</td>
<td>Azimuth Scale Mechanism</td>
<td>Fine and coarse motion thru worm and wheel</td>
<td>Fine and coarse motion thru worm and wheel</td>
</tr>
<tr>
<td>12</td>
<td>Elevation Scale</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Elevation Scale Mechanism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Orienting Mechanism</td>
<td>Fine and coarse motion thru worm and wheel</td>
<td>Fine and coarse motion thru worm and wheel</td>
</tr>
<tr>
<td>15</td>
<td>Protection of scale mechanism</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Backlash</td>
<td>Errors affect accuracy</td>
<td>Errors affect accuracy</td>
</tr>
<tr>
<td>17</td>
<td>Main Bearing</td>
<td>Tapered (friction type)</td>
<td>Tapered (friction type)</td>
</tr>
</tbody>
</table>

* The starred items in the above paragraph will be compared in the following table with the same features of the aiming Circle T3.
## RESTRICTED

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Aiming Circle T3</th>
<th>Canadian Aiming Circle</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Height</td>
<td>8-11/16 inches</td>
<td>9-1/2 inches</td>
</tr>
<tr>
<td>4</td>
<td>Scaling *</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>a. Telescope</td>
<td>Partially</td>
<td>Partially</td>
</tr>
<tr>
<td></td>
<td>b. Mechanical Assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Leveling</td>
<td>Three point leveling on instrument</td>
<td>Three point leveling on instrument</td>
</tr>
<tr>
<td>7</td>
<td>Sighting Aid</td>
<td>4x telescope with inclined (45°) eyepiece</td>
<td>4.5x telescope with inclined (50°) eyepiece</td>
</tr>
<tr>
<td>8</td>
<td>Compass</td>
<td>Yes, insensitive to dip</td>
<td>Yes, adjustable for declination</td>
</tr>
<tr>
<td>12</td>
<td>Elevation Scale</td>
<td>minus 400 to plus 800'</td>
<td>minus 15 to plus 65°</td>
</tr>
<tr>
<td>13</td>
<td>Elevation Scale mechanism</td>
<td>Fine motion thru worm and wheel</td>
<td>Fine motion thru worm and wheel</td>
</tr>
</tbody>
</table>

* Possibility of dust entering these instruments at boundaries of rotating portions.

7. There are one or two minor differences between the Canadian Instrument and the Aiming Circle T3 which are worthy of note.

a. The Aiming Circle T3 is fitted with hinged caps to protect the lower motion adjustment once a correct setting is obtained. This feature is not found on the Canadian Instrument.

b. Conical shaped micrometer drums are utilized on the Canadian Aiming Circle as opposed to cylindrical drums on the Aiming Circle T3. It is supposed that conical shaped drums provided for greater ease in scale reading.

c. It is pointed out that all scales of the Canadian Aiming Circle are graduated in degrees and minutes whereas standard practice for our instruments is to graduate all scales in mils.

8. The leveling screw knobs on the Canadian Aiming Circle are small (1-3/16 in. diameter) and may be of such a size as to cause difficulty in use where the operator may be attired in artic gear.

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9. The major disadvantage found in the design features of the Canadian Aiming Circle is connected with its tapered main bearing. The main bearing of the Canadian Aiming Circle is split in such a manner that the tapered shaft carries two separate tapered sleeves, one above the other. These two sleeves must be accurately fitted to the shaft and seated with respect to each other in order to insure the proper meshing of the upper worm gear with respect to its wheel and the lower worm gear with respect to its wheel. In practice, the lower sleeve is fitted to the shaft and adjusted so that the action of the lower worm and wheel is correct. After this is accomplished, the upper sleeve must be fitted to the shaft and seated on top of the lower shaft so that the upper worm and wheel mesh correctly and so that no binding is caused between the upper and lower sleeves under rotation. This procedure requires an instrument assembler of high skill. The main bearings of the M1 and T3 are such that one sleeve must be fitted to the tapered shaft and adjusted for the gear mesh. The tapered shaft which is hollow then is fitted to a straight bearing and adjusted for the correct mesh of the lower motion worm gear and wheel.

IV. CONCLUSIONS

1. It is concluded that in most particulars the Canadian Aiming Circle is similar to the Aiming Circle M1 and in physical size and shape much the same as the Aiming Circle T3.

2. It is concluded that the tapered bearing present in the instrument is an objectionable feature not only because of the difficulty in assembly and adjustment, but also because of a general tendency of tapered bearings to "lock up" under conditions of extreme cold. It is pointed out in passing that present practice is to eliminate tapered bearings wherever possible.

3. The scale graduations of the Canadian Aiming Circle being in degrees and minutes are unsuited for use by Army Field Forces.

4. It is concluded, finally, that, if the scale graduation were in mils, the Canadian Aiming Circle would serve the purposes of the Army Field Forces but it would represent no improvement over those instruments presently in use or proposed for use.
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FIG. 1

KEY TO FIGURE 1

1. Eyeguard
2. Securing ring, eyepiece cell
3. Graticule window, illuminating
4. Rainshade
5. Body level, circular, Mk. 2
6. Spindle cap, adjusting compass variation
7. Milled head, worm gear, No. 2
8. Plunger, compass release
9. Knurled head, elevation
10. Fluted head, worm gear, No. 1
11. Levelling screw, base supporting
12. Closing cap, telescope bubble
13. Open sight, rear
14. Bubble B, telescope
15. Housing, elevating arc
16. Recording plate, compass deviation
17. Scale plate, elevation
18. Micro drum
19. Scale, azimuth
20. Securing lugs, base supporting
KEY TO FIGURE 2

1. Securing ring, eyepiece cell
2. Bubble, spirit AE, telescope
3. Capstan nuts, adjusting bubble
4. Open sights
5. Bubble, spirit B
6. Housing, elevating arc
7. Recording plate, compass deviation
8. Micro drum
9. Scale plate, elevation
10. Scale azimuth
11. Knurled head, elevation
12. Securing lugs, base supporting
13. Knutscrews
14. Base, tribrach
15. Screws, securing lug
16. Tribrach
17. Index, azimuth scale
18. Fluted head, worm gear, No. 1
19. Plunger, compass release
20. Knurled head, worm gear, No. 2
21. Spindle cap, adjusting compass variation
22. Body level, circular, Mk. 2
23. Rainshade
24. Graticule window, illuminating
CANADIAN ARMY LOCAL
E.M.E. INSTRUCTIONS

INSTRUMENTS AND SEARCHLIGHTS
B 832 (C.A.)

FIG. 3

KEY TO FIGURE 3

1. Micro drum, gear worm, No. 3
2. Index ring, micro drum
3. Hole securing base supporting
4. Base
5. Fluted head (left) gear worm No. 1
6. Micro drum, gear worm No. 2
7. Lever, quick release, gear worm No. 2
8. Lever, quick release, gear worm No. 1
9. Knurled head, gear worm No. 2
10. Fluted head (right) gear worm No. 1
11. Plunger, compass release
12. Grooves, positioning, base supporting
13. Knurled head, gear worm No. 3

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CANADIAN ARMY LOCAL
E.M.E. INSTRUCTIONS

KEY TO FIGURE:

1. Screw, securing fluted head
2. Fluted head, left
3. Bearing, spherical
4. Bearing, spherical, split
5. Base
6. Lever, quick release
7. Spring, meshing slide
8. Screw, retaining spring case
9. Spring, torsion
10. Slide, meshing case
11. Screw, securing case
12. Screw, securing fluted head
13. Slide, antidust
14. Fluted head, right
15. Screw, securing fluted head
16. Case, securing fluted head

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KEY TO FIGURE 5
1. Worm wheel No. 1
2. Worm wheel No. 2
3. Azimuth scale
KEY TO FIGURE 6

1. Socket, vertical pivot
2. Socket, compass release plunger
3. Damping plates
4. Spacer, damping plates
5. Knurled head, gear worm No. 2
6. Case slide

7. Spring, torsional
8. Lever, quick release
9. Micro drum, gear worm No. 2
10. Index, micro drum
11. Index, azimuth scale
### Key to Figure 7

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Screw, flat head, securing nut, inner cone.</td>
</tr>
<tr>
<td>2</td>
<td>Screw, flat head, securing nut, outer cone.</td>
</tr>
<tr>
<td>3</td>
<td>Knurled head, inner cone.</td>
</tr>
<tr>
<td>4</td>
<td>Knurled head, outer cone.</td>
</tr>
<tr>
<td>5</td>
<td>Knurled head, upper head.</td>
</tr>
<tr>
<td>6</td>
<td>Knurled head, lower head.</td>
</tr>
<tr>
<td>7</td>
<td>Knurled head, middle head.</td>
</tr>
<tr>
<td>8</td>
<td>Knurled head, rear head.</td>
</tr>
<tr>
<td>9</td>
<td>Knurled head, front head.</td>
</tr>
<tr>
<td>10</td>
<td>Knurled head, side head.</td>
</tr>
<tr>
<td>11</td>
<td>Knurled head, back head.</td>
</tr>
<tr>
<td>12</td>
<td>Spring, tensioning spring.</td>
</tr>
<tr>
<td>13</td>
<td>Screw, retaining, securing knurled head.</td>
</tr>
<tr>
<td>14</td>
<td>Screw, retaining, securing knurled head.</td>
</tr>
<tr>
<td>15</td>
<td>Screw, retaining, securing knurled head.</td>
</tr>
<tr>
<td>16</td>
<td>Screw, retaining, securing knurled head.</td>
</tr>
<tr>
<td>17</td>
<td>Screw, retaining, securing knurled head.</td>
</tr>
<tr>
<td>18</td>
<td>Screw, retaining, securing knurled head.</td>
</tr>
<tr>
<td>19</td>
<td>Screw, retaining, securing knurled head.</td>
</tr>
<tr>
<td>20</td>
<td>Screw, retaining, securing knurled head.</td>
</tr>
</tbody>
</table>

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**Note:**
- From: **Canadian Army Local E.M.E. Instructions**
- **Instruments and Searchlights**
- **B 332 (C.A.)**
KEY TO FIGURE 8
1. Locking nut, adjusting screw
2. Adjusting screw, compass pivot
3. Base, compass pivot
4. Pivot, compass needle
5. Compass needle
6. Ring, retaining, compass correction arc
7. Screws securing ring
8. Compass correction arc
9. Veneer, compass scale
10. Plate, compass scale
11. Screws, securing compass scale
12. Screen, securing fibre block
13. Screws, securing damping plates
14. Spacers, damping plates
15. Damping plates
16. Screw, securing slide
17. Plunger, compass release
18. Spring, actuating plunger
19. Slide, compass clamping
20. Pivot block, compass needle.
KEY TO FIGURE 9

1. Plate, compass scale
2. Vernier, compass scale
3. Micro drum
4. Index ring, adjustable
5. Housing, elevating arc
6. Nut, adjusting bubble
7. Bubble, spirit B
8. Bubble, spirit A, telescopic
9. Knob
10. Spindle cap, adjusting compass variation
11. Vertical window, illuminating
12. Body, bubble, Mk 2
13. Bearing, right rotation
14. Focuser

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