United States Patent [19]

Koll

[11] **4,329,570**

[45] **May 11, 1982**

[54] **LEAD CALCULATOR**

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[73] Assignee: **LeadRite Corporation**, Ruleville, Miss.

[21] Appl. No.: **11,673**

[22] Filed: **Feb. 12, 1979**

[51] **Int. Cl.**[3] **G06C 27/00**

[52] **U.S. Cl.** ..... **235/78 R**; 235/70 A; 235/88 R

[58] **Field of Search** ..... 235/70 R, 70 A, 70 C, 235/78 N, 79.5, 84, 78 R–78 M, 88 R–88 RC; 33/261

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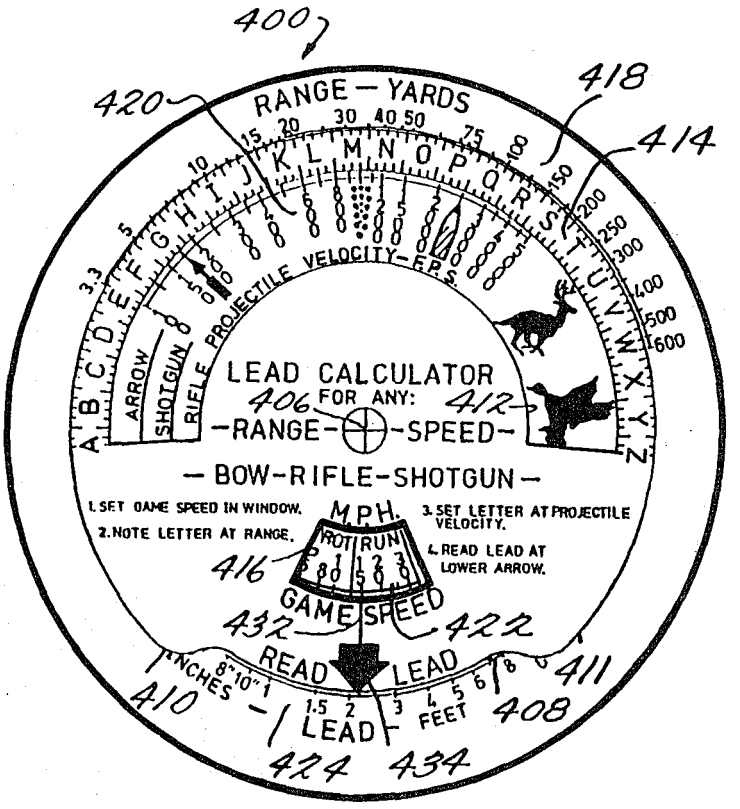
[57] **ABSTRACT**

A calculating device and a method of use thereof for determining the lead required to shoot a projectile at a moving target including cooperating logarithmic scales with indicia corresponding to the parameters target speed, range, projectile speed and lead displayed on a fixed and a slide member. Pictorial markers representative of various projectiles are disposed along the projectile velocity scale at locations corresponding to their normal speed and words descriptive of target speed are disposed at appropriate locations along the target speed scale so that calculations may be made by persons not having knowledge of game and projectile speeds in numerical terms. In accordance with one embodiment of the invention, the logarithmic scales are longitudinally disposed and the slide member may move relative to the fixed member in a horizontal direction. In accordance with other embodiments of the invention, the scales are disposed in a circular arc on members which may be rotated about a common axis.

22 Claims, 17 Drawing Figures



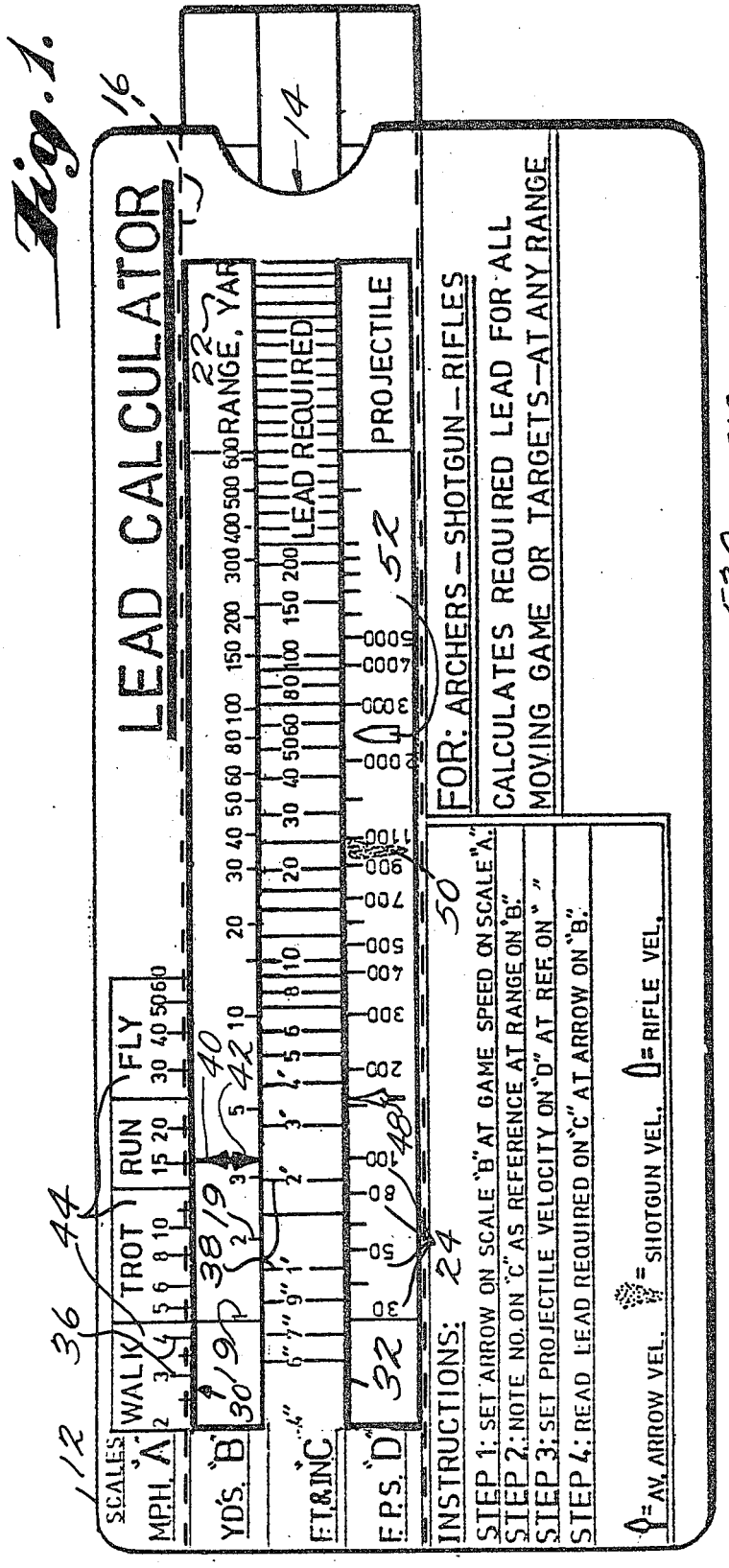


Fig. 1.

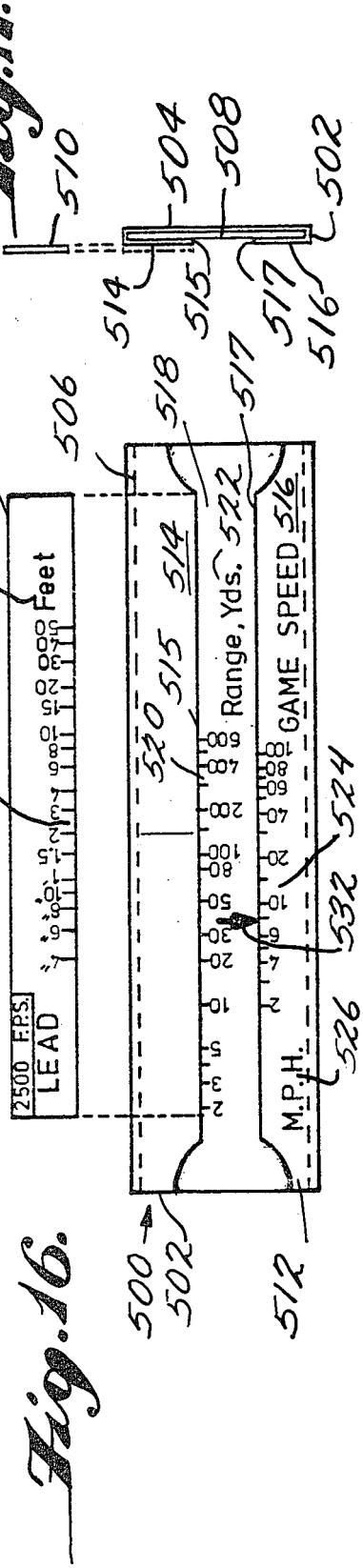


Fig. 17.

Fig. 16.

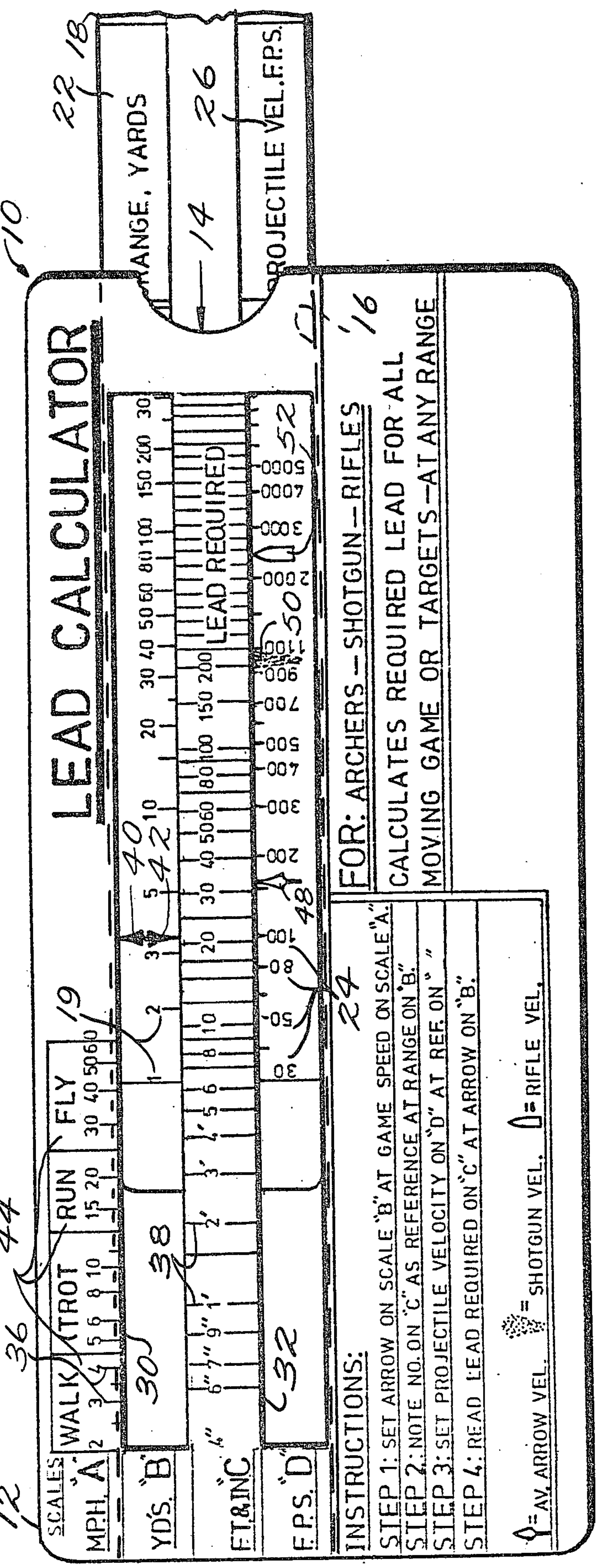

LEAD CALCULATOR
SCALES
MPH. "A"
YD'S. "B"
FT.&INC.
F.P.S. "D"
WALK
TROT
RUN
FLY
RANGE, YARDS
PROJECTILE VEL. F.P.S.
LEAD REQUIRED
FOR: ARCHERS—SHOTGUN—RIFLES
CALCULATES REQUIRED LEAD FOR ALL
MOVING GAME OR TARGETS—AT ANY RANGE
INSTRUCTIONS:
STEP 1: SET ARROW ON SCALE "B" AT GAME SPEED ON SCALE "A".
STEP 2: NOTE NO. ON "C" AS REFERENCE AT RANGE ON "B".
STEP 3: SET PROJECTILE VELOCITY ON "D" AT REF. ON "
STEP 4: READ LEAD REQUIRED ON "C" AT ARROW ON "B".
= AV. ARROW VEL.
= SHOTGUN VEL.
= RIFLE VEL.

Fig. 2.

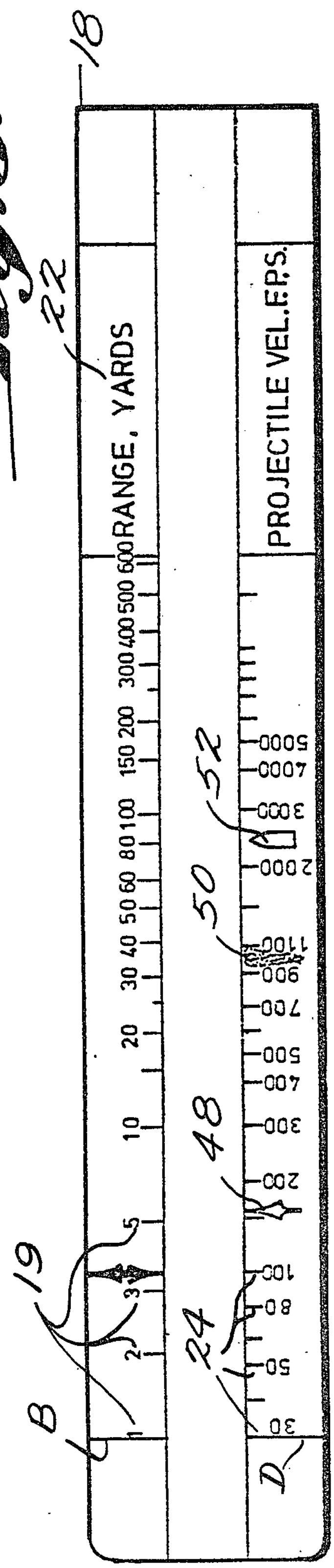

RANGE, YARDS
PROJECTILE VEL. F.P.S.

Fig. 3.

Fig. 5.

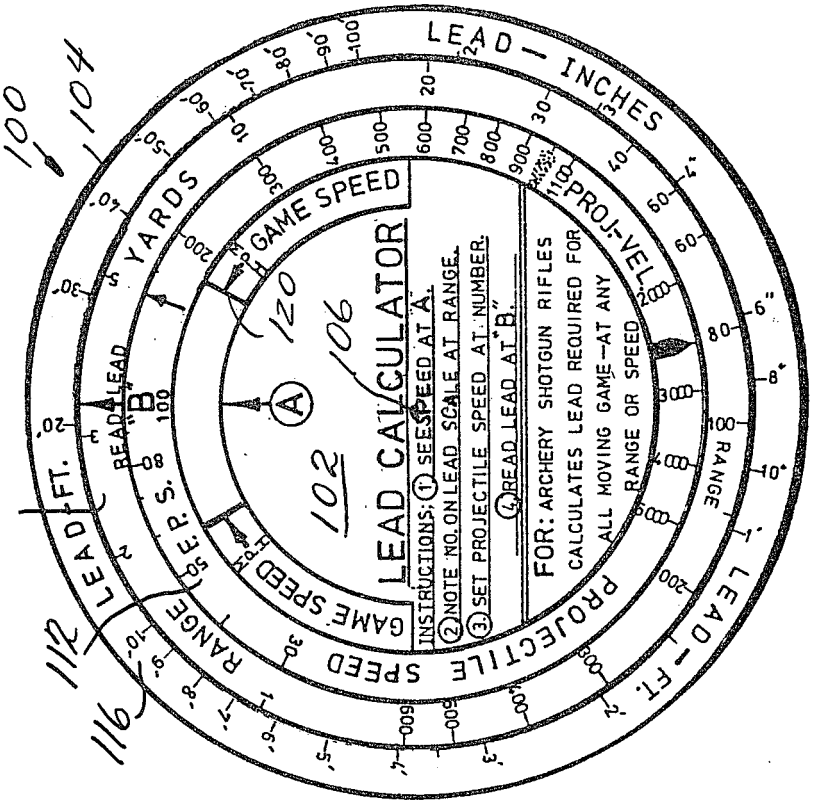

LEAD — INCHES
YARDS
GAME SPEED
LEAD CALCULATOR
INSTRUCTIONS: ① SEE SPEED AT A.
② NOTE NO. ON LEAD SCALE AT RANGE.
③ SET PROJECTILE SPEED AT NUMBER.
④ READ LEAD AT "B".
FOR: ARCHERY SHOTGUN RIFLES
CALCULATES LEAD REQUIRED FOR
ALL MOVING GAME—AT ANY
RANGE OR SPEED
PROJ-VEL
RANGE
LEAD — FT.
F.P.S.
PROJECTILE SPEED
GAME SPEED
RANGE
LEAD — FT.
READ LEAD "B"
100
102
104
106
110
112
116
120

Fig. 4.

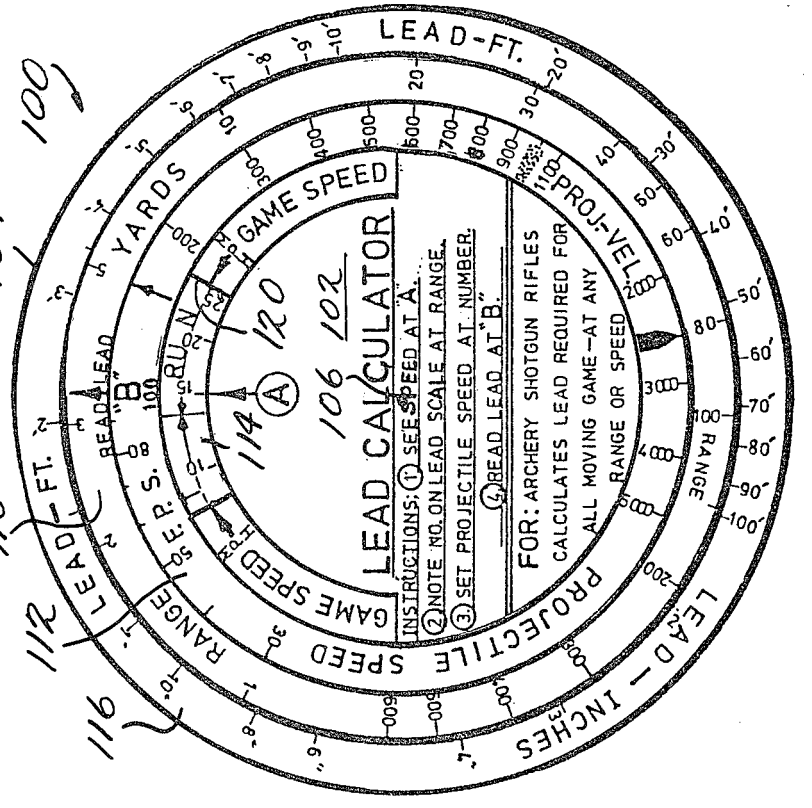

LEAD-FT.
YARDS
GAME SPEED
LEAD CALCULATOR
INSTRUCTIONS: ① SEE SPEED AT A.
② NOTE NO. ON LEAD SCALE AT RANGE.
③ SET PROJECTILE SPEED AT NUMBER.
④ READ LEAD AT "B".
FOR: ARCHERY SHOTGUN RIFLES
CALCULATES LEAD REQUIRED FOR
ALL MOVING GAME—AT ANY
RANGE OR SPEED
PROJ-VEL
RANGE
LEAD — INCHES
F.P.S.
PROJECTILE SPEED
GAME SPEED
RANGE
LEAD — FT.
READ LEAD "B"
100
102
104
106
110
112
114
116
120

Fig. 6.

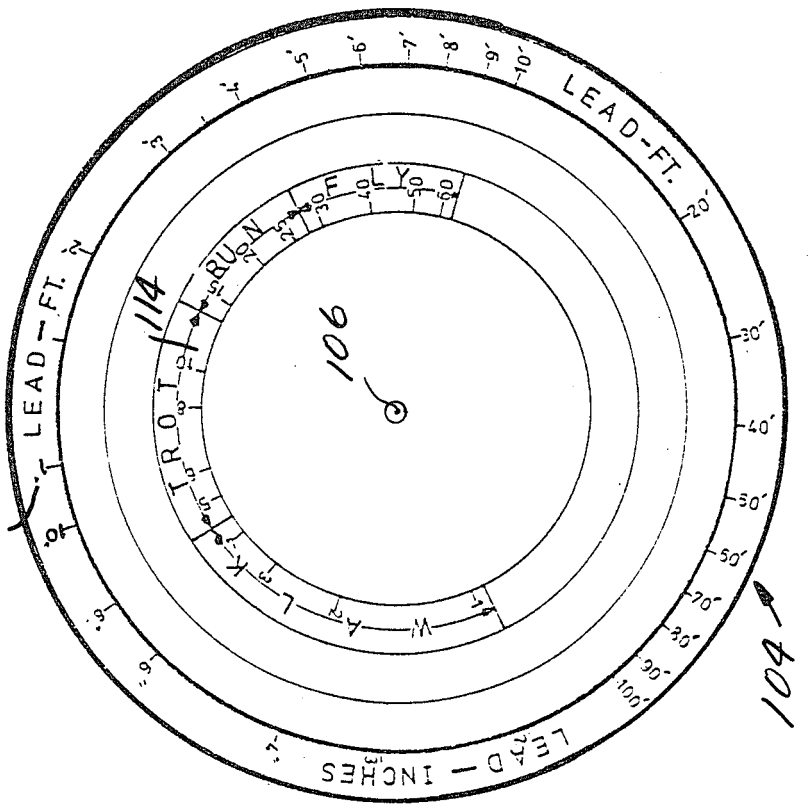
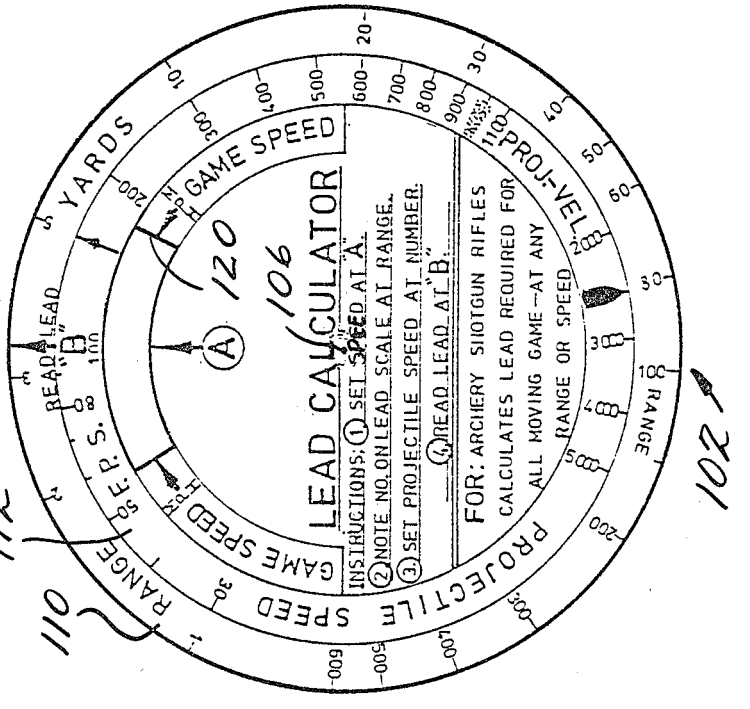

LEAD-FT.
LEAD-INCHES
106
114
116
104
TROT
RUN
WALK
SLOW

Fig. 7.


LEAD CALCULATOR
INSTRUCTIONS: ① SET SPEED AT "A".
② NOTE NO. ON LEAD SCALE AT RANGE.
③ SET PROJECTILE SPEED AT NUMBER.
④ READ LEAD AT "B".
FOR: ARCHERY SHOTGUN RIFLES
CALCULATES LEAD REQUIRED FOR
ALL MOVING GAME—AT ANY
RANGE OR SPEED
PROJECTILE SPEED
PROJ-VEL
RANGE
GAME SPEED
YARDS
READ LEAD "B"
102
106
110
112
120

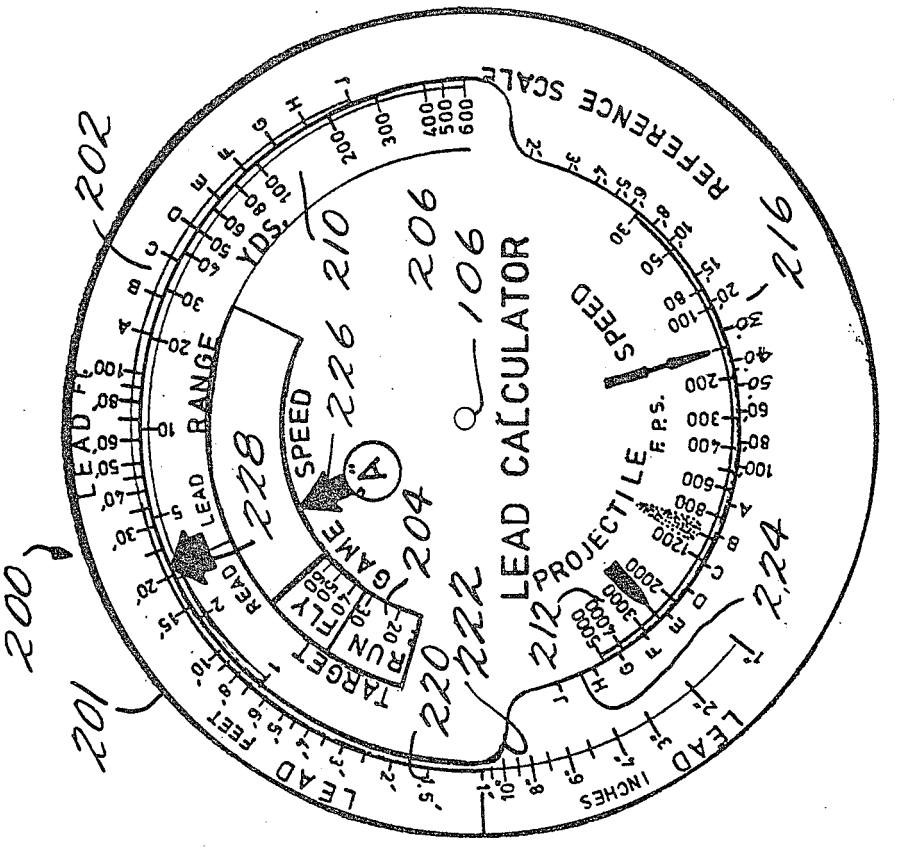

LEAD CALCULATOR
PROJECTILE
F. P. S.
SPEED
REFERENCE SCALE
LEAD RANGE
YDS.
LEAD FEET
LEAD INCHES
TARGET SPEED
GAME
RUN
FLY
TROT
WALK
A
200
201
202
204
206
210
212
216
218
220
222
224
226
228

Fig. 9.

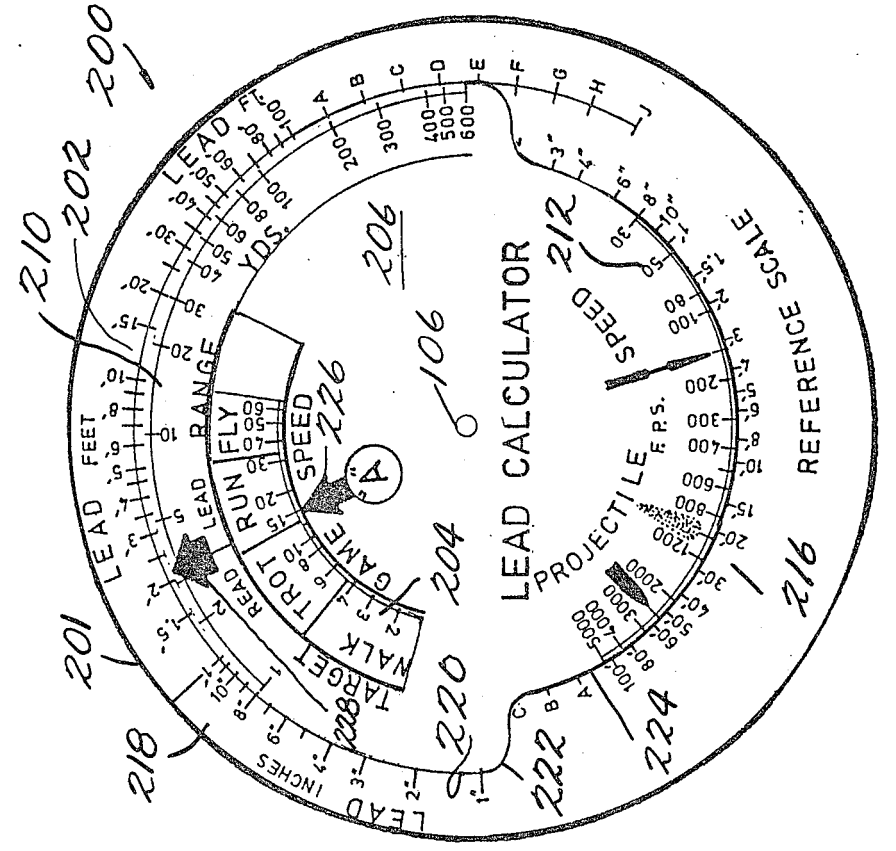

LEAD CALCULATOR
PROJECTILE
F. P. S.
SPEED
REFERENCE SCALE
LEAD RANGE
YDS.
LEAD FEET
LEAD INCHES
TARGET SPEED
GAME
RUN
FLY
TROT
WALK
A
200
201
202
204
206
210
212
216
218
220
222
224
226

Fig. 8.

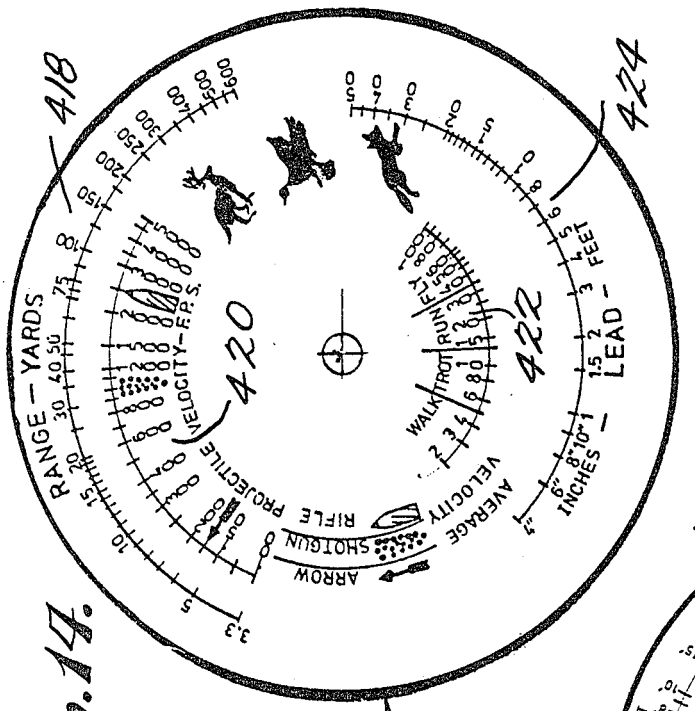


Fig. 14.

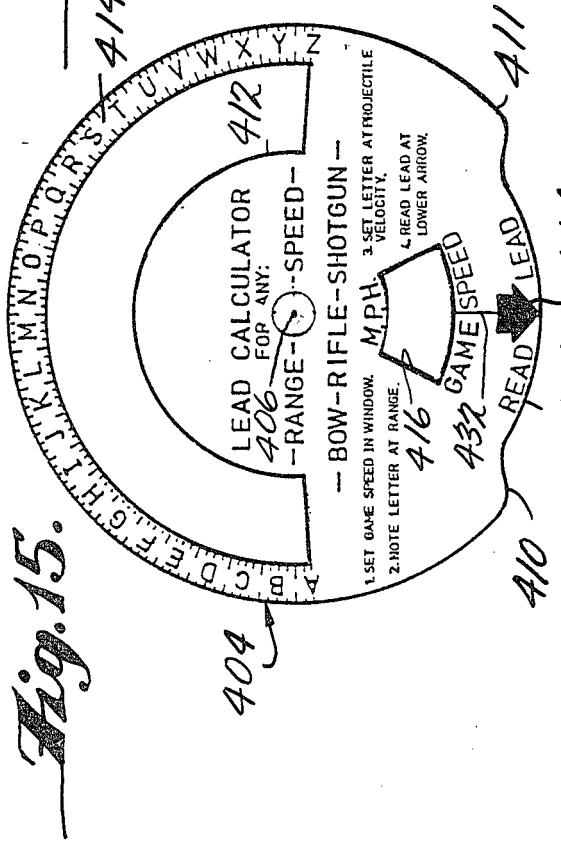


Fig. 15.

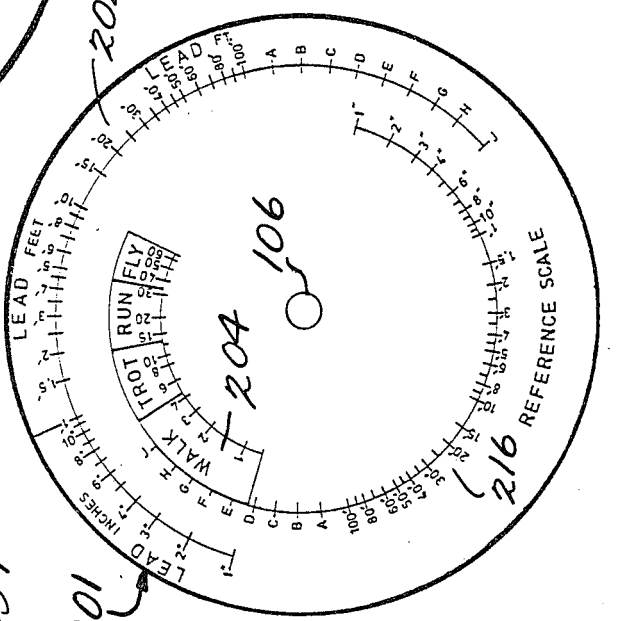


Fig. 10.

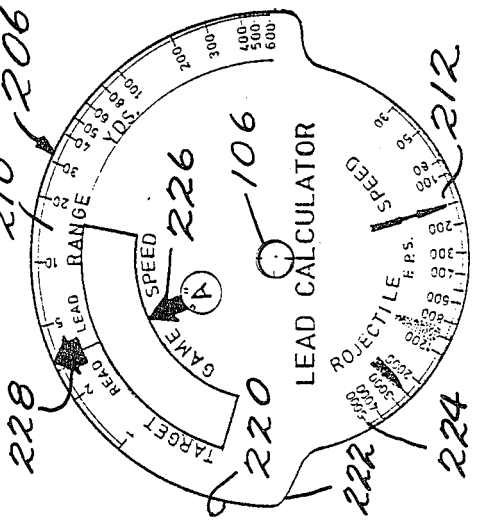


Fig. 11.

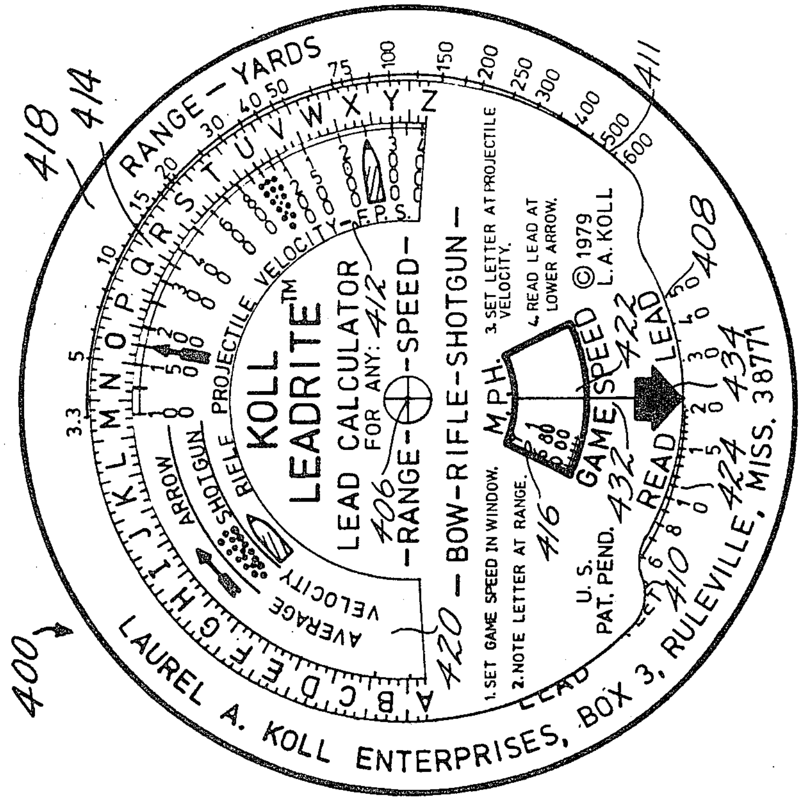

400
418
414
411
408
406
412
416
420
410
424
432
422
434
RANGE — YARDS
KOLL
LEADRITE™
LEAD CALCULATOR
FOR ANY:
-RANGE- -SPEED-
— BOW-RIFLE-SHOTGUN —
AVERAGE VELOCITY
ARROW
SHOTGUN
RIFLE
PROJECTILE VELOCITY—F.P.S.
M.P.H.
GAME SPEED
READ LEAD
1. SET GAME SPEED IN WINDOW.
2. NOTE LETTER AT RANGE.
3. SET LETTER AT PROJECTILE VELOCITY.
4. READ LEAD AT LOWER ARROW.
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Fig. 13.

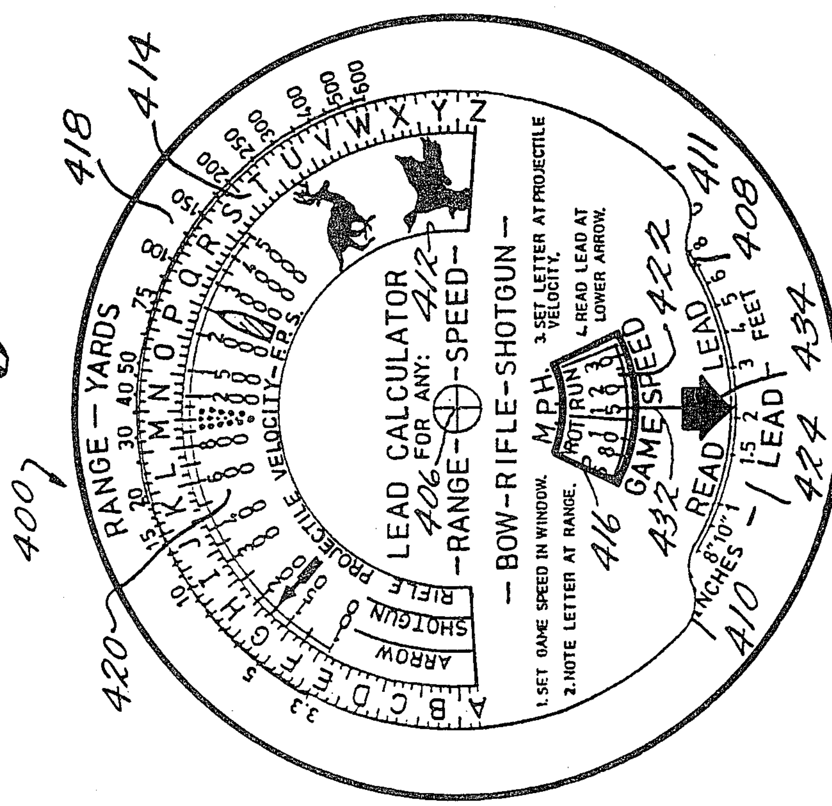
400
418
414
411
408
406
412
416
420
410
424
432
422
434
RANGE — YARDS
LEAD CALCULATOR
FOR ANY:
-RANGE- -SPEED-
— BOW-RIFLE-SHOTGUN —
ARROW
SHOTGUN
RIFLE
PROJECTILE VELOCITY—F.P.S.
M.P.H.
ROT RUN
GAME SPEED
READ LEAD
FEET
INCHES
1. SET GAME SPEED IN WINDOW.
2. NOTE LETTER AT RANGE.
3. SET LETTER AT PROJECTILE VELOCITY.
4. READ LEAD AT LOWER ARROW.

Fig. 12.

LEAD CALCULATOR

BACKGROUND AND BRIEF SUMMARY OF THE INVENTION

The invention relates to determining the lead required in shooting a projectile at a moving target and more particularly to a slide calculator for making such a determination.

It is well known that in order to hit a moving target such as skeet or game with a projectile, the projectile must be directed at a point ahead of the target location at the time the projectile is released. (The term "target" as used herein is intended to describe any moving object, living or inanimate, at which a shooter is aiming and therefore includes game.) The required distance ahead of the target is known as "lead" and the required amount of lead may be calculated from a knowledge of the directed velocity of the target, the directed velocity of the projectile and the distance from the shooter to the target at the time of shooting. The general formula for lead as a function of these variables is quite complex. However, for many applications a good approximation of the lead may be calculated by assuming that the velocity of the target and the projectile remain constant in magnitude and direction and that the distance from the shooter to the target does not change during the time of flight of the projectile. The later approximation is unnecessary if the distance measurement utilized is that from the shooter to the target at the time the projectile reaches the target. With these approximations the lead is given by the following formula:

$$L=(St\times D)/Sp$$

where

St=target speed

Sp=projectile speed

D=distance to target

In order that the formula be accurately applied the shooter must be able to estimate leads for the range of target speeds, target ranges and projectile speeds which he is likely to encounter. Leads appropriate for different circumstances may be learned with the use of the above formula. However, for many persons use of the formula may be difficult and overly time consuming. Its direct use requires a knowledge of mathematics which many shooters do not have. Furthermore, while this formula appears to be simple enough its use requires that all of the speed and distance values be expressed in the same units of speed and distance. However, it is common in the English-speaking nations to think of the speed of a target such as skeet or game in miles per hour, to think of range in yards, and to express firearm projectile velocities in feet per second. A shooter, thinking of speeds and distance in these units of measurement must first convert target speed to feet per second and range to feet, before calculating the lead in units of feet by use of the mathematical formula. This requirement substantially increases the difficulty and time required for the calculation. Another problem in determining lead encountered by many shooters, especially inexperienced game hunters is to relate the type of motion of game (e.g., walk, trot, run, fly) to a particular speed of the game or to relate the type of projectile being fired (e.g. arrow, shotgun pellets, rifle bullet) to the speed of the projectile.

These difficulties may be overcome by use of the present invention. In accordance with the principal embodiments of the invention, cooperating logarithmic scales with indicia corresponding to the parameters target speed, range, projectile speed and lead are horizontally or circularly displayed on a horizontal or circular slide rule type device, the particular indicia and scale units being those most commonly known for the particular parameter. In three embodiments of the invention the target speed and target range scales are disposed on the fixed member; the projectile speed and lead scales are disposed on the movable slide member. In a fourth embodiment all of these scales are disposed on the fixed member and a separate reference scale is disposed on the slide member. Calculation of required lead is ordinarily accomplished in two slide steps. The target speed is first multiplied by the range and the result is divided by the projectile speed to obtain the required lead as will be more fully explained in the detailed description below. In this way the required speed may be quickly and easily calculated without any conversion of units and requirements or mathematical knowledge. The calculation may of course also be made by dividing the target range or target speed by the projectile speed first, before the multiplication step (provided the scales are appropriately rearranged).

The calculation in each of the embodiments may be used in a number of shooting situations. These include game hunting, and skeet or target shooting as well as in military applications such as in shooting at various moving military targets.

In accordance with another feature of the invention pictorial markers representative of various projectiles which are commonly utilized, e.g. arrows, shot and rifle bullets, are disposed along the projectile velocity scale at locations corresponding to their normal speed, so that the lead requirement for each of these projectiles may be calculated without knowledge of actual projectile speed.

In accordance with still another feature of the invention a verbal description of target (game) speed is disposed at appropriate locations along the target speed scale so that a game hunter need only know "mode" of movement, that game is, for example, "walking," "trotting," "running" or "flying," to be able to calculate (or at least estimate) required lead.

In many instances, where the projectile speed is known for a firearm which is repeatedly used, it is very useful to have a calculator specifically designed for calculating required lead for a single projectile speed, but requiring only one slide step to make the calculation. Such a fifth embodiment of the present invention will accomplish this result. In accordance with this embodiment, there are only three scales, two being disposed on a fixed member and one being disposed on a slide member. The two scales disposed on the fixed member are offset relative to each other by such an amount as corresponds to the particular projectile speed, thereby eliminating the requirement of a division step in the calculation of required lead. In accordance with another feature of the invention, one or more of the scales used in the fifth embodiment may be formed unattached to the fixed and slide members but may be removably attached to the fixed member by the user with an adhesive at a location corresponding to the projectile speed of his particular weapon. This embodiment of the invention could be made very small, for example 1" by 5", and could be mounted directly on the

particular weapon for convenient use during a hunting situation.

BRIEF DESCRIPTION OF THE DRAWING

These and other features and advantages of the invention can be more easily understood from the following more detailed description taken in conjunction with the accompanying drawings in which:

FIGS. **1** and **2** illustrate a method by which the required lead may be calculated using a first embodiment of the invention;

FIG. **3** illustrates the indicia on the slide member of the first embodiment of the invention;

FIGS. **4** and **5** illustrate a method by which the required lead may be calculated using a second embodiment of the invention;

FIG. **6** illustrates the indicia on the fixed member of the second embodiment of the invention;

FIG. **7** illustrates the indicia on the slide member of the second embodiment of the invention;

FIGS. **8** and **9** illustrate a method by which lead may be calculated using a third embodiment of the invention;

FIG. **10** illustrates the indicia on the fixed member of the third embodiment of the invention; and

FIG. **11** illustrates the indicia on the movable member of the third embodiment of the invention.

FIGS. **12** and **13** illustrate the method by which the required lead may be calculated using a fourth embodiment of the invention;

FIG. **14** illustrates the indicia on the fixed member of the fourth embodiment of the invention;

FIG. **15** illustrates the indicia on the movable member of the fourth embodiment of the invention;

FIG. **16** is a plan view of a fifth embodiment of the invention;

FIG. **17** is a side view of the fixed member of the embodiment shown in FIG. **16**;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The lead calculator of the present invention in a horizontal slide embodiment is shown in FIGS. **1** and **2**. The lead calculator, generally designated by the numeral **10**, comprises a fixed frame **12** having means defining a hollowed out area **14** (as represented by dashed lines **16**) into which is inserted a slide member **18**. Slide member **18** is shown individually in FIG. **3**. Slide member **18** has disposed thereon two horizontal spaced apart logarithmic scales B and D. Scale B includes numerical indicia **19** corresponding to target range in units of distance, typically yards, as indicated by the verbal indicia **22** directly to the right of scale B. Scale D includes numerical indicia **24** corresponding to projectile speed, typically in units of feet per second, as indicated by the verbal indicia **26** to the right of scale D. In order that scales B and D may be visible, elongated horizontal openings **30** and **32** are suitably provided in fixed member **12** directly on top of scales D and B. Scales D and B are suitably designated as such on fixed member **12** adjacent to corresponding openings **30** and **32**. Also disposed on fixed member **12** are a logarithmic scale A having numerical indicia **36** of target speed and a second logarithmic scale C with numerical indicia **38** corresponding to required lead. Scale A is suitably disposed directly above and horizontally aligned with opening **30** and scale B. Scale C is suitably horizontally disposed between and parallel aligned with openings **30** and **32** and scales B and D. A first marker is disposed on slide member **18** for marking a particular target speed, suitably arrow **40** located on scale B. A second marker is disposed on slide member **18** for marking a particular lead on scale C, suitably downward directed arrow **42** on scale B.

In order to use calculator **10** to determine the required lead, after determining the target (game) speed, the range and the projectile speed, slide member **18** is slid so that arrow **40** is set at the target (game) speed on scale A. The point on scale C adjacent to the determined range on scale B is then noted. The slide member **18** is again moved so that the projectile velocity on scale D is adjacent to the previously noted reference point on scale C and the required lead is then read on scale C adjacent to arrow **42** on scale B.

In order to assist persons unfamiliar with the speed of game in terms of miles per hour, verbal descriptions of the mode of movement **44** are disposed adjacent to particular ranges on scale A. The descriptive words used in the present embodiment are "walk," "trot," "run," and "fly." In carrying out the above described lead calculation procedure, arrow **40** may be set adjacent to the appropriate verbal indicia of mode of game movement **36** instead of the particular game speed on scale A.

In order to assist those unfamiliar with the normal speed of various projectiles used in target shooting and game hunting, pictorial indicia of various projectiles are disposed on scale D at the location corresponding to their normal projectile velocity. In the present embodiment pictorial representations of an arrow **48**, shot **50**, and a rifle bullet **52** are shown on scale D. In carrying out the last step of the above-described calculation, the pictorial representations **48**, **50** and **52** may be utilized rather than the actual projectile velocity, depending on the projectile being utilized.

A sample calculation of lead is illustrated in FIGS. **1** and **2** for a target moving at 15 miles per hour, a target range of 50 yards, a projectile speed of 150 feet per second arrow marker **40** is set at 15 miles per hour on scale A and the point on scale C adjacent to 50 yards on scale B is noted (32 feet). As shown in FIG. **2**, the indicia of 150 feet per second on scale D is set at the reference point on scale C (32 feet) and the lead is read off of scale C (21 feet).

The above-described calculation will be an accurate reflection of required lead assuming that the speed of the projectile and the speed of the target remain constant and the calculated range reflects the total distance traveled by the projectile before reaching the target if the logarithmic scales A, B, C, and D have correlated proportions and are correlated in location with markers **40** and **42**, so that the two slide steps described above accomplish a multiplication and a division which marks the point on lead scale C representing the target speed times the target range divided by the projectile speed. The arrangements of logarithmic scales and markers which permit successive multiplication and division to be carried out on a slide type calculation are well known in the calculator art and all such arrangements are deemed to be within the scope of the present invention.

Arrows **40** and **42** may be placed at the same horizontal location on scale B, one vertically above the other, if the proportionate value at a given horizontal location on scales A and C is the same as the proportion of the values represented at the same horizontal location on scales B and D. As will be apparent from a close exami-

nation of FIG. 1, such equal proportions are utilized thereon—that proportion being 1:10 (sec-1). Thus, for example, the ratio one yard to thirty feet per second shown at one horizontal location on scales B and D, is equivalent to the ratio of 8.8 feet to 60 miles per hour shown at one horizontal location on scales C and A. When the scales are vertically aligned as described above, it is possible to determine required lead by only one movement of the slide member **18**. In this configuration, if the projectile speed on scale D is made vertically aligned with the game or target speed on scale A, then the correct lead required will be vertically aligned with the correct range on scale B. This same principal also applies to all of the embodiments described in detail below.

An alternate embodiment of the invention is shown in FIGS. **4**, **5**, **6** and **7**. This embodiment of the lead calculator designated by the numeral **100** has the form of a circular rule having a slide member **102** individually shown in FIG. **7** and a fixed member **104** individually shown in FIG. **6**. Slide member **102** and fixed member **104** are suitably circular shaped discs concentrically rotatably mounted at their center by an axle member **106**. The term "axle" is defined herein to include any suitable means for rotating two members about a axis. Slide member **102** suitably has a lesser diameter than fixed member **104**. A logarithmic scale **110** having indicia corresponding to target range and a logarithmic scale **112** with indicia corresponding to projectile speed are disposed in circular concentric arcs about axle **106** on slide member **102**. A logarithmic scale **114** corresponding to target (game) speed and a logarithmic scale **116** with indicia corresponding to required lead are disposed along circular concentric arcs about axle **106** on fixed member **104**. The lead scale **116** is suitably disposed just inside the outside circumference of fixed member **104** and target speed scale **114** is suitably disposed so as to be visible through extended circular arc opening **120** which is located on movable slide member **102** inside target range scale **110** and projectile speed scale **112**. Word indicia descriptive of target speed are disposed on target speed scale **114**, pictorial indicia representative of projectile speed disposed on projectile speed scale **112**, a target speed marker for marking particular target speed on scale **114** and a lead marker for marking a particular lead on scale **116** disposed on slide member **102** are arranged in a manner similar to the corresponding markers and indicia of the first (longitudinal slide) embodiment described above. The relationship between the four scales in the embodiment shown in FIGS. **4** through **7** are identical to those of the straight line scales of FIGS. **1** through **3** except that ranges of speed or distance are represented by angles of rotation in the second embodiment as opposed to lengths along the scales as in the first embodiment. The identical calculation as was described above and illustrated in FIGS. **1** and **2** is also illustrated for the second embodiment by FIGS **4** and **5**.

A third embodiment of the present invention is illustrated by FIGS. **8** through **11**. Referring to FIG. **8**, the third embodiment **200** is very similar to the second, having a fixed disc-shaped member **201** with logarithmic circular arc shaped lead and target (game) speed scales **202** and **204** and a concentrically rotably mounted slide member **206** having a logarithmic target range scale **210** and projectile speed scale **212** disposed in a circular arc about axle **214**. The third embodiment differs from the second embodiment primarily in having a fifth reference scale **216** similar to the range scale but disposed in a circular arc about the axle on the fixed member **201**. In this embodiment, the lead scale suitably occupies the outer circumferential portion **218** of the fixed member **201**. The slide member **206** has a first outer circumferential edge **220** on a portion of its outer perimeter **222** which may be rotated just inside of lead scale **202** on the fixed member **201** and a second circumferential edge **224** at a lesser radial distance from the axle which occupies the remainder of the perimeter of the slide member **206**. The projectile speed scale **212** is disposed along the second circumferential edge **224** of the slide member **206** and the reference scale **216** is disposed on the fixed member at such a distance from axle **214** that the second circumferential edge **224** may be rotated immediately inside the reference scale **216**. Game speed scale **204** is visible through arc shaped opening **225** in slide member **206**.

In order to calculate the required lead using the third embodiment of the lead calculator, after determining the projectile speed, the game or target speed and the range, target speed marker **226** is set at the determined target speed. The value on the lead scale adjacent to the determined range is then noted and the determined projectile speed is set at the noted value on the reference scale **216**. The lead is then read adjacent to lead marker **228** on the lead scale **202**. This procedure is illustrated in FIGS. **8** and **9** for a target speed of 15 miles per hour, a projectile speed of 150 feet per second and a range of 50 yards. The determined lead, as in the altenate embodiments described above, is calculated at 21 feet.

A fourth embodiment of the invention is shown in FIGS. **12**, **13**, **14** and **15**. This embodiment of the lead calculator designated by the numeral **400** has the form of a circular rule having a fixed member **402** individually shown in FIG. **14** and a slide member **404** individually shown in FIG. **15**. Fixed member **402** and slide member **404** are suitably circular shaped discs concentrically rotatably mounted together at their centers by an axle member **406**. Slide member **404** suitably has a lesser diameter than fixed member **402** and an arc shaped indented edge **408** forming a portion of its outside edge **410**. The remainder of outside edge **410** is designated by the numeral **411**. Slide member **404** also has an extended opening **412** in the shape of a circular arc near a portion of the circular edge **411**. A reference scale **414** suitably a linear scale with alphabet reference markings, is disposed on member **404** in a circular arc between opening **412** and edge **411**. A second circular arc shaped opening **416** in member **404** near edge **408**. Reference scale **414**, opening **412** and **416** and indented edge **408** are all circular arc shaped and have their center of rotation at axle **406**. On fixed member **402** a logarithmic scale **418** having indicia corresponding to target range, a logarithmic scale **420** with indicia corresponding to projectile speed, a logarithmic scale **422** with indicia corresponding to target (game) speed and a logarithmic scale **424** with indicia corresponding to required lead are disposed along circular concentric arcs about axle **406**. Range scale **418** is arranged to be visible adjacent to edge **410**, projectile velocity scale **420** is arranged to be visible through opening **412**, target speed scale **422** is arranged to be visible through opening **416** and required lead scale **424** is arranged to be visible along edge **408**. As in the previously described embodiments of the present invention, word indicia descriptive of target (game) speed are disposed on tar-

get speed scale **422** and pictorial indicia representative of projectile speed are disposed on projectile speed scale **420**. A target speed marker **432** is disposed adjacent opening **416** for marking the target speed on scale **422** and marker **434** is disposed on member **404** adjacent indented edge **408** for marking the require lead on scale **424**.

In order to calculate the required lead using the fourth embodiment of the lead calculator, after determining the projectile speed, the target speed and the range, target speed marker **432** is set at the determined target speed on scale **422**. The reference marking on the reference scale **414** adjacent to the determined range is then noted and the determined projectile speed is set at the noted reference marking. The lead is then read adjacent to the lead marker **434** on the lead scale **424**. It will be noted reference scale **414** serves a similar function as a cursor on conventional sliderules. This procedure is illustrated in FIGS. **12** and **13** for a target speed of 15 miles per hour, a projectile speed of 150 feet per second and a range of 50 yards. The determined lead, as in the alternate embodiments described above, is calculated at 21 feet.

The fifth embodiment of the present invention, illustrated in FIGS. **16** and **17**, is specifically designed for calculating required lead for a single given projectile speed but requires only one slide step to make the calculation. Referring to FIG. **16**, the fifth embodiment of the present invention, generally designated by the numeral **500**, is shown to include a fixed member **502** having a means defining a hollowed out area **504** (as represented by dashed lines **506**) into which is inserted a slide member **508**. Also included in the fifth embodiment of the present invention is attachable membe **510** which may be attached and detached from fixed member **502** as by the use of an adhesive as will be described. Fixed member **502** suitably has a front surface **512** including an upper front surface **514** having a lower edge **515** and a lower front surface **516** having an upper edge **517** separated by a longitudinally extended opening **518**. Slide member **508** has disposed thereon a logarithmic scale **520** with numerical indicia corresponding to target range in units of distance, typically yards, as indicated by the verbal indicia **522** directly to the right of range scale **20**. Horizontally disposed on fixed member lower front surface **516** along edge **517** is a logarithmic scale **524** with numerical indicia corresponding to target speed, in units of miles per hour, as indicated by the verbal indicia **526** directly to the left of target speed scale **524**. Attachable member **510** suitably composed of cardboard or a plastic material, has disposed thereon a logarithmic scale **528** with numerical indicia corresponding to required lead in units of distance, typically feet, as indicated by the verbal indicia **530** directly to the right of lead scale **528**. Range scale **520** is disposed on slide member **508** so as to be visible through opening **518** in fixed member **502**. A target (game) speed marker, suitably arrow **532**, is also disposed on slide member **508**, visible through opening **518** along edge **517** of surface **516** along which target speed scale **524** is disposed.

In order to attach attachable member **510** to fixed member **502** so as to permit calculations of required lead for a particular projectile speed, it is necessary only to align the lead scale **528**, the range scale **520** and the target speed scale **524** so that by using the numerical values on the three scales directly adjacent to marker **532**, the target speed times the range divided by the projectile speed of the arm to be used is equal to the lead value adjacent to marker **532**. Thus, referring to FIG. **16**, with the marker **532** being adjacent to a range value of 40 yards and being set at 30 miles per hour on the target speed scale **524** and for a projectile speed of 2500 feet per second, the 2.1 foot marker on the lead scale would be aligned with the 30 miles per hour mark on the target speed scale **524**. With the attachable member **510** so attached to the fixed member **502**, once the range and target speed have been determined, the marker **532** need only be aligned with the determined target speed and the lead read off adjacent to the determined range.

The simplified calculations of the fifth embodiment may of course also be accomplished with a two member device, all of the scales being permanently disposed thereon, the device being manufactured for use in making lead calculations based on a single projectile speed.

Although six particular embodiments of the invention have been disclosed in detail above, for illustrative purposes, it will be understood that variations or modifications of the disclosure which lie within the scope of the appended claims are fully contemplated. For example, there are a multitude of possible arrangements of the four logarithmic scales of embodiments **1**, **2**, **3** and **4**, the reference scales in embodiments **3** and **4** and the three logarithmic scales of embodiment **5** which will make similar calculations of lead. Division steps in the calculation of lead may also be carried out using logarithmic scales disposed in a reversed direction. Also, any of the three scales utilized in the fifth embodiment may be made detached or detachable from the fixed member with the same calculational results being possible. It will also be appreciated by those skilled in the art, that various other calculating devices such as nanograms and slide charts can be adapted to make similar calculations of lead by using properly arranged logarithmic scales and indicia as described above.

What is claimed is:

1. A lead calculator for calculating the required lead in predetermined units of linear distance as a function of target speed, target range, and projectile speed for shooting at a moving target comprising:

a fixed member and a slide member moveable with respect to said fixed member; and

at least four scales including

a first logarithmic scale with indicia representing target range along a line of sight from the projectile launching point to the point of intended impact,

a second logarithmic scale with indicia representing target speed,

a third logarithmic scale with numerical indicia representing required lead; and

a fourth logarithmic scale with indicia representing projectile speed;

said first, second, third and fourth scales being disposed on at least one of said fixed and slide members in physical proximity so that they are correlated;

a non-logarithmic reference scale disposed on the other one of said members;

said first and third scales having indicia of differing predetermined units of linear distances;

said slide member having indicia means disposed thereon for marking the calculation of required lead in terms of distance, perpendicular to the line of sight;

said calculation requiring moving said slide member relative to said fixed member at least one time so as

to align said first, second and third scales so that the required lead may be readily determined.

2. A lead calculator for calculating the required lead when shooting a projectile at a moving target, as a function of three parameters, the parameters including target speed, target range and projectile speed, the calculator comprising:

five scales including

a first logarithmic scale having corresponding indicia designating quantitative representations of target speed,

a second logarithmic scale having corresponding indicia designating quantitative representations of target range,

a third logarithmic scale having corresponding indicia designating quantitative representations of projectile speed

a fourth logarithmic scale having corresponding indicia designating quantitative representations of required lead and

a reference scale;

a first member;

a second member slidable in relation to said first member;

said first, second, third and fourth logarithmic scales being disposed on said first members;

said reference scale being disposed on said second member;

said first through fourth scales having relative positions and such relative proportions that the product of the target speed and the target range divided by the projectile speed may be readily determined by moving said second member in relation to said first member to a first relative position determinable from the value of two of said parameters, noting a first location on said reference scale adjacent a location on one of said first through fourth scales corresponding to the value of one of said parameters and moving said first member to a second relative position determinable from said noted first location and the value of said one of said parameters.

3. A lead calculator as is claim 2 wherein:

said second member further includes first means for marking a particular target speed on said first scale and second means for marking the value of the lead parameter on said fourth scale;

said first relative position being defined by said first marking means marking the value of the target speed parameter on said first scale;

said first location on said reference scale being adjacent the location of said second scale corresponding to the value of the range parameter; and

said second relative position being defined by said first location on said reference scale being adjacent the indicia representative of the value of the projectile speed parameter on said third scale.

4. A lead calculator as in claim 3 further comprising an axle member, said first and second members being mounted on said axle member for rotation about a common axis.

5. A lead calculator as in claim 4 wherein each of said scales are disposed in circular arcs, said arcs being concentrically disposed on said members about said axis.

6. A lead calculator as in claim 5 wherein said second member has at least two arcuate windows for viewing at least two of said first, second, third and fourth scales.

7. A lead calculator as in claim 6 wherein the scales viewable through said arcuate window includes said third scale, said calculator further comprising:

a plurality of pictorial representations of particular corresponding projectiles disposed on said third scale at places corresponding to the speed at which said corresponding projectiles are normally fired so as to be visible through one of said windows; and

a legend, formed on said first member adjacent said third scale and visible through said one window for verbally identifying said plurality of projectiles.

8. A lead calculator as in claim 2 further comprising at least two pictorial representations of particular corresponding projectiles disposed on said third scale in a place corresponding to the speed at which said corresponding projectile is normally fired.

9. A lead calculator as in claim 8 wherein said at least two pictorial representations have the shapes of said corresponding projectiles.

10. A lead calculator as in claim 2 wherein said reference scale is linear.

11. A lead calculator as in claim 2 further comprising verbal descriptive indicia formed on said first scale, said verbal descriptive indicia corresponding to predetermined intervals of numerical indicia.

12. A lead calculator as in claim 11 wherein said moving target comprises game, said verbal descriptive indica including a plurality of indicia qualitatively descriptive of the speed of said game.

13. A lead calculator as in claim 11 wherein said verbal descriptive indicia include "walking," "trotting," "running" and "flying".

14. A device for calculating the required lead when shooting a projectile at a moving game, as a function of game speed, game range and projectile speed, comprising:

a first logarithmic scale having numerical indicia associated therewith corresponding to game speed;

a second logarithmic scale having numerical indicia associated therewith corresponding to the required lead;

a third logarithmic scale having numerical indicia associated therewith corresponding to game range;

a fourth logarithmic scale having numerical indicia associated therewith corresponding to projectile speed;

descriptive indicia formed on said first logarithmic scale for designating predetermined intervals of game speed corresponding to particular modes of movement of said game such as walking, trotting, running and flying; and

a reference scale disposed on a first member;

said first, second, third and fourth scales and said descriptive character indicia being formed on a second member and disposed in physical proximity with each other so that they are correlated, the correlated numerical value associated with the required lead scale being readily determinable if the correlated numerical value associated with the projectile speed scale, the correlated numerical value associated with the game range and either the correlated numerical value or the interval descriptive indicia formed on the game speed scale are known.

15. A device for calculating the required lead when shooting a projectile at a moving target, as a function of target speed, target range and projectile speed, comprising:

at least one member;

four scales including

a first logarithmic scale having numerical indicia associated therewith corresponding to target speed,

a second logarithmic scale having numerical indicia associated therewith corresponding to the required lead,

a third logarithmic scale having numerical indicia associated therewith corresponding to target range, and

a fourth logarithmic scale corresponding to projectile speed; and

a plurality of indicia respectively corresponding to different projectiles disposed at predetermined locations on said third scale corresponding to the normal speed of said projectiles when they are shot;

said first, second, third and fourth scales being formed on said at least one member and disposed in physical proximity with each other so that they are correlated, the correlated numerical value associated with the required lead scale being readily determinable if the correlated numerical value associated with the target range scale, the correlated numerical value associated with the target speed scale and the particular projectile being shot are known.

16. A device as in claim **15** further comprising a plurality of word indicia corresponding to separate intervals of target speed disposed at corresponding locations adjacent said first scale.

17. A device as in claim **14** or claim **15**, wherein the target speed is scaled in units of miles/hour, the required lead is scaled in units of feet, the target range is scaled in units of yards and the projectile speed is scaled in units of feet per second.

18. A method for calculating required lead in predetermined units of linear distance as a function of target speed, target range and projectile speed for shooting a projectile at a moving target, utilizing a first member; a second member slidable in relation to said first member; a first logarithmic scale having indicia representing target range along a line of sight from the projectile launching point to the point of intended impact, a second logarithmic scale having indicia representing target speed; a third logarithmic scale having indicia representing required lead in terms of distance perpendicular to said line of sight; and a fourth logarithmic scale representing projectile speed, said scales being disposed on at least one of said first and second members in such proximity to each other that they are correlated; and non-logarithmic marking indicia disposed on said second member for marking the calculation of required lead when said second member is moved relative to said first member, the method comprising the step of:

sliding said slide member in relation to said first member so as to align said marking indicia disposed on said second member with the numerical indicia corresponding to the required lead, the target speed and the target range, the required lead being readily determinable thereby.

19. A method for calculating the required lead when shooting a projectile at a moving target as a function of three parameters, the parameters being target speed, target range and projectile speed, utilizing a calculator comprising at least five scales including a first scale having corresponding indicia of target speed, a second logarithmic scale having corresponding indicia designating quantitative representations of target range, a third logarithmic scale having corresponding indicia designating quantitative representations of projectile speed, and a fourth logarithmic scale having corresponding indicia designating quantitative representations of required lead; said lead indicia and said target indicia having differing units of length, said target speed indicia and said projectile speed indicia having differing units of speed; the calculator further comprising a first member and a second member slidable in relation to said first member, said first through fourth logarithmic scales being disposed on said first member and being structurally correlated a reference scale formed on said second member; said method comprising the steps of:

(1) sliding said second member in relation to said first member so as to determine a point on said reference scale corresponding to the product of the target speed and the target range; and

(2) sliding said second member in relation to said point on said first member in order to determine a value equal to the product of target speed and target range divided by the projectile speed.

20. A method as in claim **19** wherein step (2) comprises the step of sliding said second member so as to align said point with the pictorial representation of the particular type of projectile being shot disposed on said third scale at a position corresponding to the normal speed of said type of projectile when shot.

21. A method of calculating required lead, as a function of three parameters including target speed, target range and projectile speed, when shooting at a movable target with any of a variety of projectiles utilizing a calculating device comprising at least five scales including a first logarithmic scale having corresponding indicia designating quantitative representations of target speed, a second logarithmic scale having corresponding indicia designating quantitative representations of target range, a third logarithmic scale having corresponding indicia designating quantitative representations of projectile speed, a fourth logarithmic scale having corresponding indicia designating quantitative representations of required lead and a reference scale; a first member; a second member slidable in relation to said first member; said first, second, third and fourth logarithmic scales being structurally correlated and being disposed on said first member, said second member having disposed thereon said reference scale, said method comprising the steps of:

(1) moving said second member in relation to said first member to a first relative position determinable from the value of one of said three parameters, a first location on said reference scale there being disposed adjacent a second location on said first member, said second location on one of said first, second or fourth logarithmic scales corresponding to the value of a second one of said three parameters; and

(2) moving said first member to a second relative position determinable from said noted first location and the value of a third one of said three parameters.

22. A method as in claim **19** or claim **21** wherein the target comprises game, said first scale has marked thereon a plurality of designated intervals of speed of the game and verbal indicia, correlated to said intervals, corresponding to modes of movement of the game, such as "walking," "trotting," "running" and "flying", one of the step (1) and step (2) including the steps of aligning a point on said first scale within the interval of speed corresponding to the actual mode of movement of the game with a point on one of the second or fourth scales.

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