

108,172

PATENT



SPECIFICATION

Application Date, July 17, 1916. No. 9991/16.

Complete Left, Jan. 8, 1917.

Complete Accepted, July 17, 1917.

PROVISIONAL SPECIFICATION.

**A Field Gunnery Calculating Slide Rule for use with the
18 Pounder Q.F. Gun.**

I, GEORGE DUNCAN CAMPBELL STOKES, No. 5 T.F. Artillery Training School, Scotton Camp, Catterick, Yorks, of 17, Windsor Terrace, Langside, Glasgow, 2nd Lieut., R.F.A., do hereby declare the nature of this invention to be as follows:—

- 5 This rule consists of a boxwood frame carrying two wooden slides capable of free motion along the length of the rule and capable of being reversed end for end or of being turned rear side up.
Scales are engraved as follows:—
On the face of the rule, elevation, range, point of burst, exterior angle.
10 On the upper face of the slide, base, sub-base angle, apex angle, corrector change.
On the rear face of the top slide, 100 *per cent.* zone, (Mk. IV shell) decrease range setting.
On the back of the rule, setting ranges for air temperature, charge tempera-
15 ture headwind, barometer; also correction for gunrange.
On the under face of the lower slide, temperature (air or charge) ° F, headwind, barometer; with an arrow and an index mark C.
On the sloping edge of the rule, map scale.
On the actual instrument scales would be coloured (or otherwise visually
20 connected) as follows:—
Red, corrector change and point of burst setting range for air temperature, charge temperature and temperature (air or charge) ° F.
Blue, setting range for barometer and barometer.
The mathematical basis of the design and the method of use of the rule are
25 not stated in this Provisional Specification.

Dated this 13th day of July, 1916.

G. D. C. STOKES, 2ND LIEUT., R.F.A.

COMPLETE SPECIFICATION.

**A Field Gunnery Calculating Slide Rule for use with the
18 Pounder Q.F. Gun.**

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I, GEORGE DUNCAN CAMPBELL STOKES, 2nd Lieut., 261st Siege Battery, R.G.A., 17, Windsor Terrace, Langside, Glasgow, do hereby declare the
[Price 6d.]

nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This rule consists of a boxwood frame of dimensions shown in the diagram and carries two boxwood slides (front and rear) capable of free motion along the length of the frame. The centre piece of the rule is made flexible to improve the movement of the slides. Scales are engraved as follows:—

On the face of the rule, Fig. 1,—elevation, range, height of burst, exterior angle. On the face of the top slide—base, 50 yard sub-base angle, apex angle corrector change. On the back of the rule, Fig. 2,—setting ranges in thousands for air temperature charge temperature, wind and barometer, correction for gunrange. On the face of the rear slide—temperature (air or charge), headwind, barometer. On the front of the sloping edge—map scale 1 in 20,000.

In the actual rule the following scales are coloured—1. Red—corrector change, height of burst, arrow index at right end of base scale, setting range for air temperature and charge temperature, temperature (air or charge). 2. Blue—setting range in 000 for headwind, headwind. Fig. 3 shows back of rule with slide removed.

MATHEMATICAL BASIS OF THE DESIGN.

1. Formula used for range, base, apex angle, exterior angle scales 20

$$\tan C = \frac{c}{b} \frac{\sin E}{1 + \frac{1}{10} \cos E}$$

where E is the exterior angle at apex A in the triangle ABC. In field gunnery B is the battery position, C the target, A the observer's post, *b* the range from observer to target, *c* the range from observer to battery, and E the exterior angle measured by the observer at A.

2. Formula used for corrector change and height of burst scales 25

$$\text{Corrector change} = \frac{20,000}{R} (h - 10)$$

where R is the range and *h* the height of burst of shell above the line of sight. This formula expresses the rule laid down in "Field Artillery Training" 1914 page 164 para. 7.

3. Formulae used for corrections for gunrange arising from temperature, wind and barometer. 30

Air	correction for gunrange	=	$\frac{1}{10} (t - 60) f_1(R)$	}	yards
Charge	"	=	$\frac{1}{10} (t - 60) f_2(R)$		
Wind	"	=	$\frac{1}{10} w f_3(R)$		
Barometer	"	=	$\frac{1}{10} (b - 30) f_4(R)$		

where *t* is the temperature in degrees F, *w* the wind velocity in feet per second, *b* the barometric pressure in inches of mercury and $f_1(R)$ is the gunrange correction at range R shown in the range table of the 18 pounder gun (*etc.* for $f_2(R)$).

4. Elevation, sub-base angle, 100 per cent. zone, Mark I range indicator:—
For the sub base scale the values of 50 cot (sub base angle) were calculated for 3°, 4°, . . . 15° and marks placed opposite these values on the base scale. The other scales were designed in a similar way from the range table of the 18 pr. gun. 40

The scales designed under paragraphs 1, 2, 3 above are logarithmic.

TABLES OF ACTUAL SCALE MEASUREMENTS AND COMPARATIVE READINGS.

Base to which measures refer
Front, mark 10 on base scale; mark 0 on 1:20,000 scale 45

Barom. setting range	Barom. setting range		Eleva- tion Range		← Comparative readings →		Ex- terior Apex		
	Cm.	Cm.			Sub base angle	Base	angle	angle	
2000	5.05	4000	12.60	30'	420	3°	955	20'	1° 47'
2100	5.52	4100	12.85	40	550	4	715	30	2° 38
2200	5.93	4200	13.07	50	680	5	570	40	3 22
2300	6.35	4300	13.33	1°	810	6	475	50	4° 5
2400	6.76	4400	13.57	2°	1480	7	407	60	4 42
2500	7.18	4500	13.80	3	2000	8	356	70	5 5
2600	7.56	4600	14.05	4	2530	9	316	80	5 25
2700	7.98	4700	14.29	5	3000	10	283	90	5 43
2800	8.41	4800	14.51	6	3425	11	257	100	5 36
2900	8.84	4900	14.74	7	3810	12	245	110	5 20
3000	9.26	5000	14.97	8	4175	13	217	120	5 2
3100	9.66	5100	15.19	9	4525	14	201	130	4 30
3200	10.05	5200	15.38	10	4840	15	186	140	3 55
3300	10.42	5300	15.59	11	5160			150	3 5
3400	10.79	5400	15.79	12	5450			160	2° 5'
3500	11.12	5500	15.99	13	5725				
3600	11.43	5600	16.18	14	6020	80	2000	230	4300
3700	11.75	5700	16.40			90	2190	240	4420
3800	12.05	5800	16.59			100	2350	250	4570
3900	12.35	5900	16.78			110	2520	260	4680
4000	12.60	6000	16.97			120	2690	270	4800
						130	2840	280	4900
						140	3000	290	5000
						150	3160	300	5140
						160	3310	310	5300
						170	3450	320	5440
						180	3600	330	5600
						190	3640	340	5730
						200	3860	350	5850
						210	4000	360	6000
						220	4150		

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

A slide rule adapted for field artillery calculations, comprising on the front of the rule, fixed scales for elevation, range, height of burst, and exterior angle; on the back of the rule, setting ranges for air temperature, charge temperature, headwind and barometer; and on the slide, scales for base, sub-base angle, apex angle, and corrector change, temperature, headwind and barometer, substantially as described.

Dated the 4th day of January, 1917.

G. D. C. STOKES, 2ND LIEUT., R.G.A.

FIG 1



FIG 2

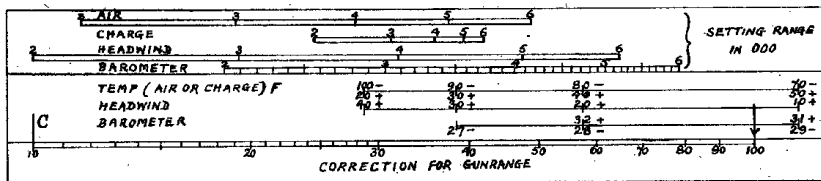
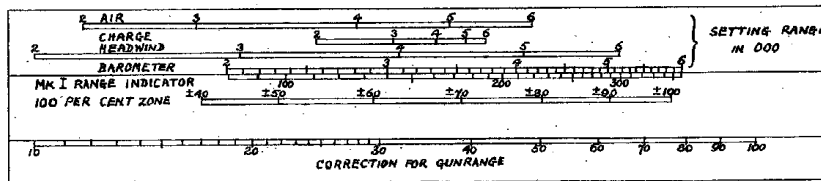


FIG 3



SCALE 10 CMS

[This Drawing is a reproduction of the Original on a reduced scale.]



[This Drawing is a reproduction of the Original on a reduced scale.]

FIG 1

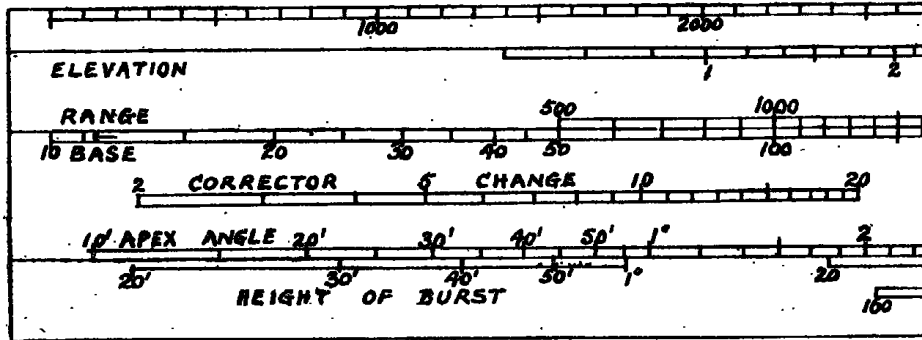


FIG 2

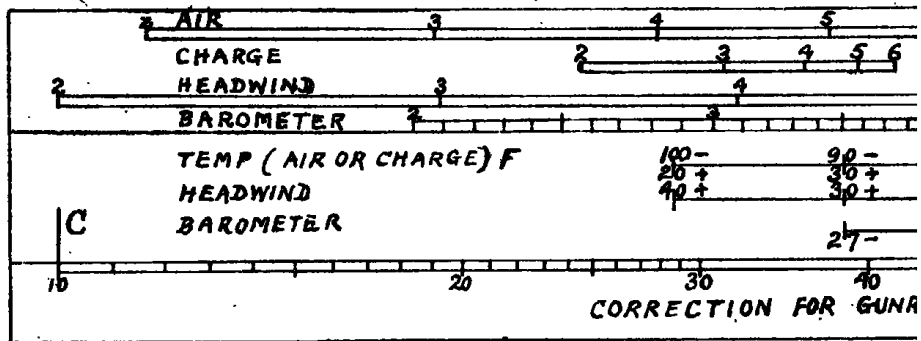
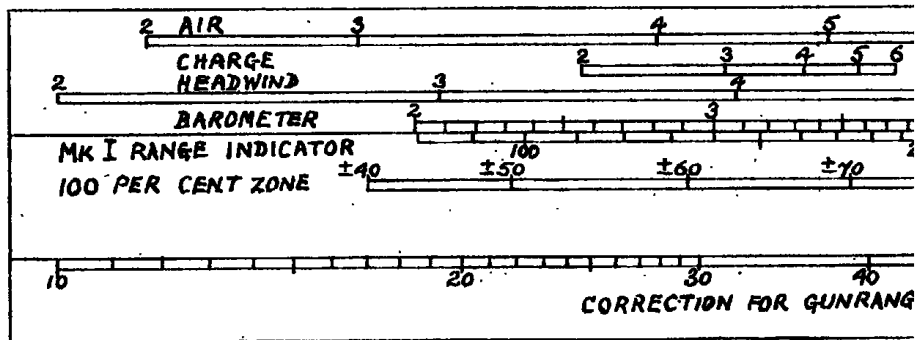
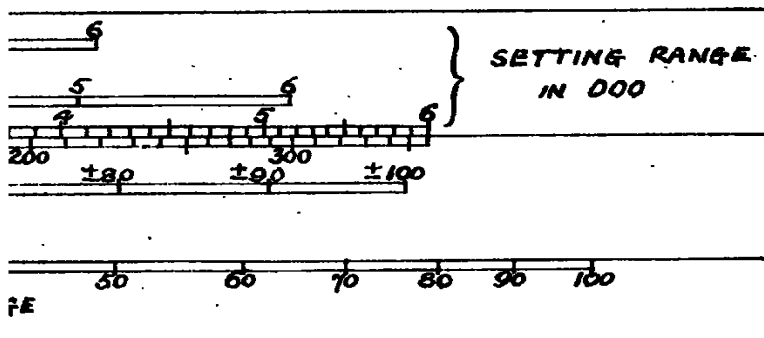
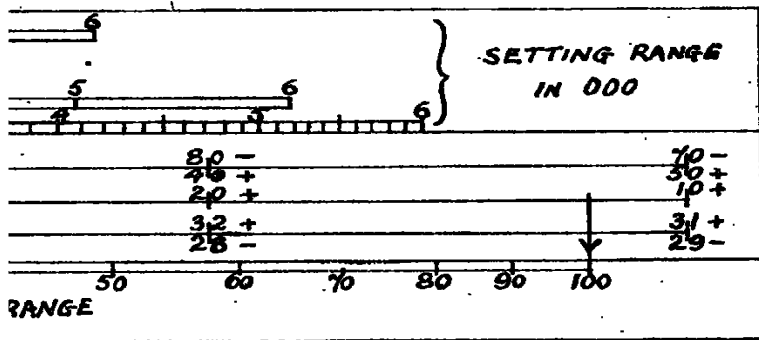
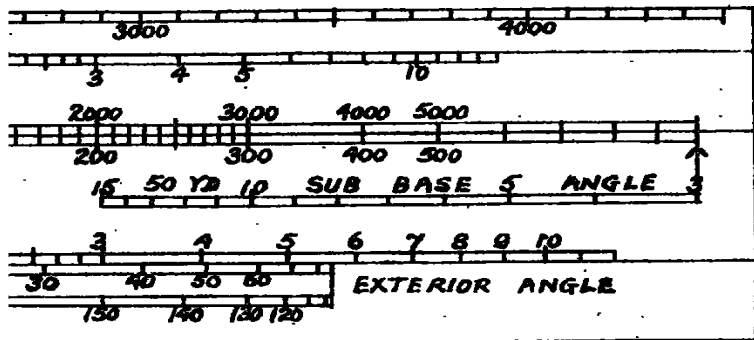


FIG 3



SCALE 9



10 CMS

