PATENT **SPECIFICATION**



Application Date: Jan. 5, 1925. No. 28,557 / 25.

254.5

Complete Accepted: July 5, 1926.

COMPLETE SPECIFICATION.

Improvements in or relating to Tabular Calculating Apparatus particularly for use in the Laying of Ordnance.

I, WILLEM FREDERIK GROTENDORST, of Koningstraat 4a, Helder, Holland, a subject of the Queen of Holland, do hereby declare the nature of this inven-5 tion and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:-

This invention relates to tabular calcu-10 lating apparatus particularly for use in the laying of ordnance. The invention is particularly intended for use in conjunction with the device described in the Specification No. 254,351.

The main purpose of this invention is to provide a tabular device which shall permit of calculating the distance of an object or target from data obtained by observations taken from both ends of a 20 known base line.

The present invention consists in an improved tabular calculating apparatus comprising a logarithmic scale constituted by a series of rows of equal lengths 25 arranged one below the other, a ruler three times the length of a row carrying an adjustable indicating mark and uniformly graduated to indicate lengths in terms of the length of a row as a unit 30 and adapted to be used in combination with said logarithmic scale, and an antilogarithm table for converting lengths read from the ruler into the data required, said table giving a plurality of 35 answers for each fraction of a unit, so that when the answer is approximately known the ruler need only be read to the nearest two places of decimals in order to obtain an approximation correspond-40 ing to the use of three figure logarithms.

log. $Z_2D = \log b + \log \sin a - \log \sin t$ (1)

From this formula the distance Z₂D can be calculated, which distance is [Price 1/-]

One form of the present invention is illustrated for the sake of example in the accompanying drawings in which:-

Fig. 1 indicates the positions of two observation posts and an object, and 45 corresponds with part of the Fig. 1 of my above mentioned Specification No. 254,351.

Figs. 2 to 5 show the various elements of the apparatus, which are intended to 50 be used in combination.

Figs. 2 and 2ª show portions of a logarithmic chart indicating angles.

Figs. 3 and 3° show an anti-logarithm table for converting logarithms into 55 distances.

Fig. 4 shows a logarithmic rule with cursor.

Fig. 5 shows an indicating plate. In Fig. 1, Z₁ and Z₂ represent two 60 observation posts provided with angle measuring instruments, and D represents the position of an object or target. The distance Z_1 $Z_2 = b$. α is the bearing angle at which the object or target is 65 seen from Z_1 , and β is the supplement of the bearing angle at which the object or target is seen from Z_2 . t is the socalled vertical angle.

The angles α and β are measured simultaneously at the posts Z_1 and Z_2 .

From this we find $\angle \beta - \angle \alpha = \angle t$.

In $\triangle Z_1 Z_2$ D the following elements are now known: $Z_1 Z_2 = b \angle Z_1 DZ_2 = \angle t$ and $\angle DZ_1 Z_2 = a$.

From this triangle may be obtained the Z_2D : Sin a=b; sin t which reduces to

 $Z_2D = \frac{b \sin a}{\sin t}$, whence

necessary for determining certain data required for the indirect laying of ordn

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ance, as described in the Specification No. 254.351.

The calculation of Z₂D according to the Formula (1) would of course in practice require too much time and therefore according to the invention a tabular calculating apparatus is used, the various details of which are illustrated in the Figures 2, 3, 4 and 5. By this calculating 10 device a simple displacement of some parts, which may be done by unskilled hands, permits of immediately reading Z_2D . The usual table of logarithms works with numbers which must be 15 added or subtracted. The principle of the calculating table constructed according to the invention is that it adds or subtracts lines, which lines, as regards their length, correspond with the 20 logarithms. Keeping this in view the arrangement of the calculating device will be easily understood.

This calculating device consists of a table of angles (Figures 2 and 2^a) three tables of distances (one of which is shown in Figures 3 and 3^a), four rulers with transparent slide (in Figure 4 one of them is shown) and a small transparent plate of special shape (Figure 5).

In the table of angles log. $\sin \alpha$ and \log sin t are indicated, in the ruler \log . b, and in the table of distances log. $\mathbb{Z}_2\mathbb{D}$. This is effected in the following way:-

The table of angles (Figures 2 and 2a) 35 is constituted by a number of rows arranged under each other and provided with graduations showing degrees and minutes. The degrees and minutes are indicated by numbers under and above 40 the marks, namely the degrees in large type and the minutes in small type. The numbers indicating angles greater than 90° are arranged under the corresponding rows, and those which indicate 45 angles less than 90° are arranged above the rows. The mark indicating 90° is arranged at the top right-hand corner, so that proceeding from this point the rows run from the right to the left and then 50 downward to the next row, etc., above the rows the angles decrease from 90°, and under the rows the angles increase

Furthermore the numbers 9, 8, 7, 6, 5, 4, 3, 2, 1, 0, 9, 8, 7, 6 and 5 are arranged beside the rows 1—15. These numbers represent the first decimal of the log. sines, so that in the uppermost row are found all the angles of which the first decimal of the log. sines

from 90° .

60 is 9; on the second row from the top are the angles of which the log. sines is 8, etc.: If for instance $\angle a = 46^{\circ}$ 30', log. $\sin a = 0.86056 - 1$ and therefore $\angle 46^{\circ}$ 30' will be found in the second row from the ¢5 top, the first decimal of the log. sines

being 8 and this number 8 being found

opposite said second row.

The position of the angles in the row depends on the second and third decimal of the log. sines. It is sufficient to take the log. sines to three places of decimals. Again taking as example $\angle a = 46^{\circ} 30'$, log sin a is taken 0.861 - 1. The second and third decimal form the number 61. The angle 46° 30' is now found at $2 \times 61 = 122 \%$. going to the right from the beginning of the row (the whole row

being 200^{m} , long). Similarly log sin 10° 20' = 0.254 - 1. The angle 10° 20' is therefore found in the row opposite which 2 is placed, namely at $2 \times 54 = 108$ m/m. to the right from the beginning of the row.

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By setting the angles in this way in the rows it follows that the difference of the distances of two angles exactly constitutes the number which must be added to $\log b$ (i.e. $\log \sin a - \log \sin t$) in order to obtain log Z₂D. The rulers by which this difference is determined may be used at both sides and contain at each side three groups of numbers, each group running from 0—100. The subdivisions are such that said difference of distances may be read accurately to the nearest Each group is as long as one unit. row of the table of angles, so that the ruler has three times the length of such The figures arranged opposite the marks are those which constitute the 100 second and third decimal of the logarithm of a distance.

Above and underneath the middle group of numbers other graduations are provided on which the length of the base 105 $Z_1 Z_2 = b$ at intervals of 5 metres (by the use of four rulers, for instance, it is possible to work with bases between 800 metres and 5000 metres).

The last-mentioned graduations are 110 made such that the distances given correspond with the logarithmic divisions in the middle portion of the ruler, i.e. each graduation of distances is placed opposite that mark of the logarithmic scale 115 which denotes the second and third decimal of the logarithm of the distance concerned.

In order to adjust the ruler to a certain distance a transparent slide M, 120 made for instance of mica and provided with two indicating points is provided. In order to adjust this slide to a given distance it is so set that the vertical line connecting the two indicating points 125 coincides with the graduation showing the used bases. Furthermore above each group of numbers on the rulers the letter V occurs, whether or not followed by a number preceded by a plus or minus 130

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mark. This letter V shows the difference between the first decimals of log $\sin a$ and $\log \sin t$, which first decimals are found in the table of angles opposite the rows of distances. This difference usually constitutes the first decimal of log Z₂D. However, it is possible that this first decimal of log Z₂D is one more or one less. For this 10 purpose the indications V+1, V+2 etc., are used. If upon the middle group of the ruler V+1 is marked then the right part of the ruler must be marked V, and the left part of the ruler must be marked 15 V + 2.

By adjusting the slide upon the ruler to the distance Z_1Z_2 and then placing the ruler itself with this indicating point opposite the angle a in the table of 20 angles, and by further observing by the aid of the transparent plate shown in Figure 5 which number of the ruler is found in the same perpendicular with the angle t in the table of angles, there 25 is only determined, strictly speaking, the second and third decimal of log Z2D obtained from the equation $\log b + (\log b)$ $\sin \alpha - \log \sin t$).

The first decimal of log Z₂D is indi-30 cated in the table of distances namely at the left opposite the rows of distances. while the numbers formed by the second and third decimal of log Z₂D are also shown in the table of distances, namely 35 above the rows of distances. It is advisable that the second and third decimals of log Z₂D should be indicated both on the ruler and on the table of distances in

40 Three tables of distances are used, one for distances between 1 and 4 kilometres, one between 4 and 10 kilometres and one between 10 and 32 kilometres. By way of example the table 4-10 kilometres is 45 shown in Figures 3 and 3a. Each table of distances is provided with two rows of preferably red numbers (from 0-49 inclusive and from 50-99 inclusive) which as stated above form the second 50 and third decimals of log Z₂D. Under every red number we find under each other four preferably black numbers, which indicate the distances corresponding to these logarithms. In the draw-55 ing the usual artillery notation is followed, in which the two numbers before the hyphen indicate hundred of metres, and the number behind the hyphen so many times 25 metres, so that

sents a distance of 3975 metres. In this way two times four horizontal rows of distances are formed. Opposite each of these rows a number is placed 65 which as stated above corresponds with

60 for instance the notation 39-3 repre-

V and therefore forms the first decimal of $\log Z_2D$.

If the calculations are to be effected on the assumption that the base Z_1Z_2 is 1403 metres for example: then that ruler is taken on which said distance is found, and the indicator of the mica slide is adjusted as exactly as possible to 1403 metres (see Figure 4). The ruler is then ready for use. The table of angles (Figures 2 and 2^a) is then placed ready for use and the table of distances (Figure 3) is attached to it for instance by means of clips. The choice of the table of distances depends on the distance at which a target may be expected. In the example assumed here this distance is between 4 kilometres and 10 kilometres. The table of distances referring thereto is indicated in Figures 3 and 3a. The ruler which is arranged ready for use is laid in any place on the table of angles, parallel to the rows occurring on that table. Furthermore, a transparent indicating plate (Figure 5) is taken in the right hand, and the operator then waits until the angles a and t are deter-

For the sake of clearness the concrete example will be further worked out, and it will be assumed that $\angle a=41^{\circ}$ 36' and $\angle t=\angle\beta-\angle a=8^{\circ}$. The operator looks up \(\alpha \) in the table of angles and finds it on the second row from the top, at one mark to the right from the 30 mark lying between 41° and 42°. The ruler is then displaced horizontally by the left hand over the table of angles until its indicating point is set vertically above the \(a \) i.e. 41\(36'\). He then ascertains, 105 by displacing by the right hand the transparent plate, which red number of the ruler is now vertically above the vertical angle i.e. above 8°. This appears to be about 26. Below the red number 26 on 110 the table of distances the distance Z₂D is now found. However, four distances are found there namely 42-1, 53-1, 67-0 and 84-1. As a rule there is no doubt which of these four distances is 115 the correct one, because from the previous measurement the distance is already known approximately. It may therefore only occur at the first calculation that it is not known which of the 120 four distances is to be chosen. If the distance is measured by a range-finder there is no doubt possible, because although the measurement at large distances is very inaccurate, yet at any 125 rate its accuracy is sufficient to indicate which of the given four distances is correct. If no range-finder is at hand, it is still possible by the construction of the calculating device to make the 130

right choice at the first measurement. This may be done as follows: -- Opposite the rows on which in the table of angles the angles a and t occur numbers are '5 indicated. In the given examples these are the numbers 8 and 1. The difference V of these is taken, i.e. 7. Above the group of numbers to which the number read from the ruler (26) belongs is indicated V+1. Now from the four distances, that one must be chosen which belongs to the horizontal row opposite which is the number V+1, in the given case 7+1=8. The correct distance is therefore 6Y-0. i.e. 6700 m. In practice the use of the calculating device is very simple. It only consists in displacing with both hands the ruler and the mica plate.

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:-

1. An improved tabular calculating 25 apparatus particularly for use in the laying of ordnance, comprising a logarithmic scale constituted by a series of rows of equal lengths arranged one below the other, a ruler three times the length of a row carrying an adjustable indicating mark and uniformly graduated to indicate lengths in terms of the length of a row as a unit and adapted to be used in combination with said logarithmic scale, and an anti-logarithm table for converting lengths read from the ruler into the data required, said table giving a plurality of answers for 40 each fraction of a unit, so that when the answer is approximately known the ruler need only be read to the nearest two places of decimals in order to obtain an approximation corresponding to the use 45 of three figure logarithms.

2. A tabular calculating apparatus as claimed in Claim 1, comprising (a) a table of angles, (b) one or more tables of distances, (c) one or more rulers with a 50 transparent slide belonging thereto, and (d) preferably a transparent indicating plate, the table of angles consisting of a

number of rows arranged one below the other in which the angles from 0° to 90° are continuously marked off increasing from the lowest row upward, and those from 90° to 180° continuously increasing from the uppermost row downward in such a way that those angles, the first decimal of whose log sine is the same, are arranged in the same horizontal row, said first decimals being indicated opposite their corresponding rows and the angles being so marked out in the various rows that the distances from the beginning of the row are proportional to the fraction indicated by the second and third decimals of the log sine, the tables of distances being constituted by two times four horizontal rows of disarrangedone below the tances in which the distances, other, decimal of whose logarithm $_{
m first}$ $_{
m the}$ same, are arranged the same horizontal row, said first decimals being indicated opposite their corresponding rows, while those distances, the second and third decimals of whose logarithms are the same, are arranged in the same vertical row, said second and third decimals being indicated above the row, the rulers being divided into three parts, of which each part is as long as a horizontal row of the table of angles and is provided with a scale graduated from 0-100, said graduations corresponding to the fraction formed by the second and third decimals of the logarithms of a distance, a second scale being provided on the central part, the graduations of which indicate distances and are set out in such a way that each distance of second scale corresponds to that point of the first-mentioned logarithmic division which indicates the fraction formed by the second and third decimals of the distance in question.

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3. The improved tabular calculating apparatus substantially as hereinbefore described and illustrated in the accom- 100

panying drawings.

Dated this 12th day of November, 1925.

MARKS & CLERK.

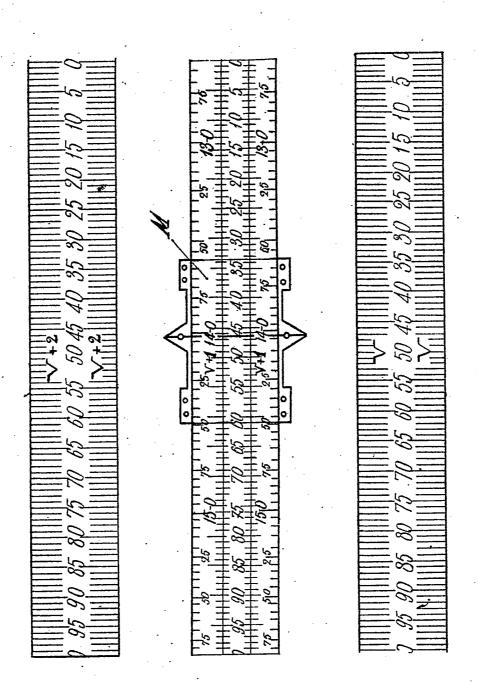
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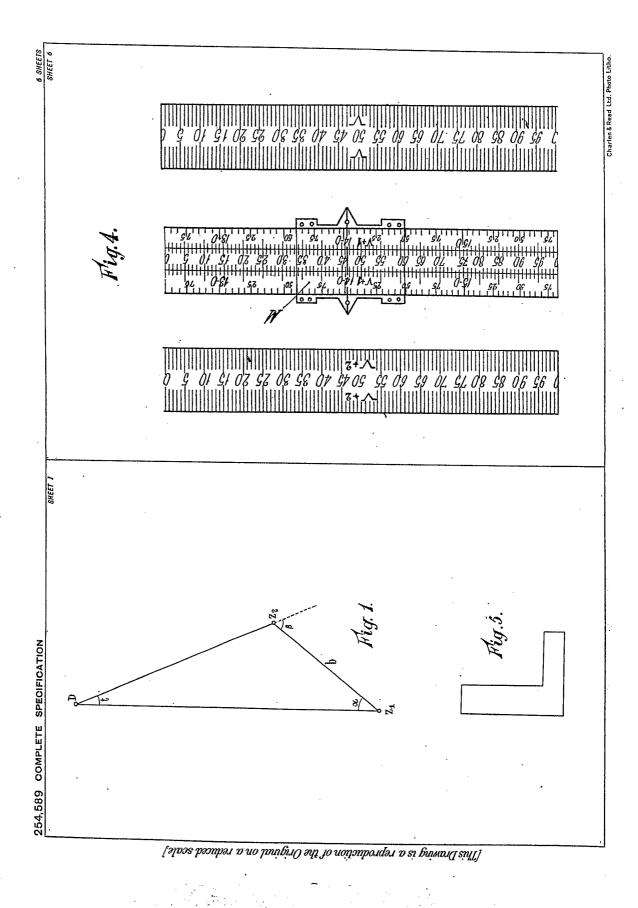
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Fig.4.

<u>T 1</u>



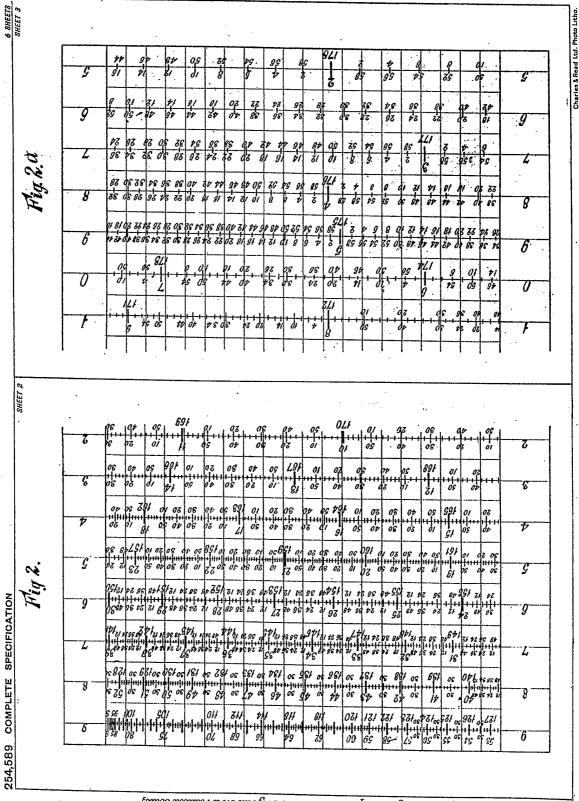
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8	8	7	9	3	4	20	64		
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8	5/ 30 08 30	28.28	24 36 	23	8 20	0 4 0 4	204		-
	2000	2 2	29 12	20 10	200	9, 05	2. 2		
	930 56	48 48 36	36 48	80 30 40 30	02 03	400	69,		-
2 3	3 8 8 8 8 8 8	\$ 100 mm	200	6±3	20 30	20 //0	3 0		
1	13 1 60	200	36 48 28 1 	0 50 22	<u> \$‡\$</u>	1 ±	1 1		_
5 + 3	4 30 183 30	36 24 16	24 36 48 11 11 11 36 24 12	20 30 40 	0 ± 0	20 30	20	• .	-
3 11	46 134 80	12/4/2	27 /2	+ + + -	20 10	50 4	30 + 30		-
7 1 3		36 24 36 24 36 24	36 48	50 21 10 	30	187	2 4		-
29	3 3 3	24	24 ++ ++ 8 36	2 2	8 6	200 1	20		
<u> </u>	1386	7 7 36 72 7	1544	20 S	16 16 16 16 16 16 16 16 16 16 16 16 16 1	03	01/		
59 60 11 11 11 10 10 10 10 10 10 10 10 10 10 1		83 - 27 2 - 47 2 - 47	1 86 48 1 12 24 12	0,00	25 0	9 9			-
5. 100	: a # a	30 24 1	46 36	20 20	20 40	2 3	0/0/		•
1 1 1	OF TOO	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	12 125	30 40	30	200	2 2 2 2		`.
30 55 30 56 30 57	41 30	24 3 1+1+1 36 24 1	8 8	8 8	5 50 40	12	30		-
30 55	30	3/ 12	45 24 48 38	161 50 40 8c	15	8 0	- ‡		-
12 of 24 of 78,	12 24 35 4540 44+++ ++ ++ ++	12 24 36 44 81 12 24 30 48 32 12 24 34 48 36 24 12 14 8 36 24 12 14 8 36 24 12 14 8 36	36 48 24 12	2 ± %	95	8 0	8 4		
23 + 68	12 24 14 36 90	1, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8,	36	30 20	40	‡	5 - 5		
6	8	7	9	2	7	85			-

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- SHEET 2	Fig. 2.a	ET 3
2	7 0 6 8 1 9 %	
8 8	20 20 20 20 20 20 20 20 20 20 20 20 20 2	,
50 40	26 24 28 38 48 38 48 48 48 48 48 48 48 48 48 48 48 48 48	
99 189	25 25 25 25 25 25 25 25 25 25 25 25 25 2	
40 50 40 150 20 100	2 2 4 2 2 8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	
30 ++	2	
2 4	2	
0.00	φ + 1	
02.4	25 25 25 25 25 25 25 25 25 25 25 25 25 2	
32	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	
30	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	
# 4 4		
000		-
2	7 0 5 8	-



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

SHEET	4

				T	ig.	3.					
23	0.74	502 503 51-0 51-0 51-0 51-1 51-2 51-2 51-3 51-3 52-0 52-0 52-1 52-2 52-2 52-3 53-0	899	83.3		133	0-14	1-83	74-2	901 901 902 903 91-0 91-1 91-2 91-2 91-3 92-0 92-1 92-2 923 93-0 93-0 93-1 93-2 93-3 94-0	
29	41-3	523	299	83.2		27	0.14	59.1	14-1	93.3	
16.	6-14	52.2	1.99	83-1		11	463	590	740	93.2	
20	41.3	285	1.99	83-1		01	8-94	069	74-0	1-86	
61	41-2	585	099	830		69	46-2	583	73.3	930	
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23	40-1 40-1 40-2 40-2 40-2 40-3 40-3 41-0 41-1 41-1 41-1 41-2 41-2 41-2 41-3 41-3 42-0	521	633 64-0 64-0 64-1 64-1 64-2 64-3 65-0 65-0 65-1 65-2 65-3 65-3 65-0 65-1 66-1 66-2 66-3	801 802 803 810 810 811 81.2 813 813 820 821 822 823 823 834 831 831 831 832		55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73	45-1 45-1 45-1 45-2 45-2 45-3 45-3 46-0 46-0 46-1 46-1 46-2 46-2 46-3 46-3 45-3 47-0 47-0	563 57-0 57-0 57-1 57-1 57-2 57-3 57-3 58-0 58-0 58-1 58-1 58-2 58-3 58-3 58-0 59-0 59-0 59-1 58-1	71.3 71.3 72.0 72.0 72.1 72.2 72.3 72.9 73.4 73.4 73.2 73.3 73.5 73.5 74.0 74.0 14.2	086	
17	41.2	250	6.99	822	· ,	67	462	58.5	78-3	923	
91	1-11	520	7.99	82.2		99	46.	1-89	732	35.5	1 1
15	41-1	21.3	299	1-28		92	1-94	1-85	78-1	1-26	
4/	41-1	21.3	1.59	820		64	0.94	0.89	13-1	920	
13	0-14	215	0.99	8/3		89	0.97	58-0	78-0	8-16	·
12	41-0	3/5	0:99	8/8		29	654	573	72.3	8-16	
#	40.8	1-19	64.3	81.2		10	453	879	72.3	3-16	
01	403	1-19	Z-#g	1-18		00	45.3	572	72-2	1-16	
8	40-2	51.0	1-79	0-18		23	45-2	57.1	1.87	0-16	
80	40-2	0-15	1-79	010		28	452	11/5	250	803	
7	Z-07	0-19	040	803		27	1-54	070	0-81	30.5	·
9	1-0#	503	0-159	80.2		20	1-97	27-0	77-3	1.06	
, Co	1-0#	508	<i>E-E9</i>	108		22	1-94	563	2/1/-3	1-06	
4		50-5	<i>&</i> 89	1-08	-	54			71-8	30.0	
3	40-0	203	63.2	0-08	:	53	0.50	295	11-1/	88.3	
0 1 2 3	40-0	50.0 50.1 50.1 50.2 50.2	68 0 63-1 63-1 63-2 683	79-2 79-2 79-3 80-0 80-1		50 51 52 53 54	44-3	295	70-3 71-0 71-0 71-1 71-2	89-11 89-1 89-2 89-3 90-0	
1	400	1-05	1.29	7,92	· · · · · · · · · · · · · · · · · · ·	21	644-3	1.99	0-11	1.6%	
0	39-3 40-040-040-0 40-0	20.0	089	79.5		09	44-2 44-3 44-3 45-0 45-0	E95 Z95 Z95 1-95 1-95	70-3	1)-68	
	9	7	80	9			9	7	8	8	

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SHEET 4

Fig. 3.a

				1	'U	r. J.	•				·
49	44.2	1-95	703	890	ļ.	99	50.6	93.0	1-61	99.5	
48	44.2	200	70.5	883		88	0.09	8-79	790	66	
47	44-1	560	1-01	88-2		16	49-3	02.3	788	1-66	
9#	1-77	553	001	1-88		96	49-3	2-29	78.3	0.66	
45	0.44	552	70-01	0-88		35	49-2	1-79	78-2	98-0	
##	440	552	889	0-88		94	49-2	039	1.81	883	
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49	423 423 430 430 430 480 43-1 43-1 43-2 43-2 43-2 43-3 43-3 44-0 440 440 44-1 44-1 44-1 44-1	53.3 54.0 54.1 54.1 54.1 54.2 54.2 54.3 54.3 55.0 55.0 55.1 55.1 55.2 55.2 55.3 56.0 56.0 56.1	673 673 689 681 681 682 683 690 691 691 691 692 692 693 700 700 70-1 702 703	85-1 852 853 860 860 86-1 862 863 863 870 871 872 873 88-0 88-0 88-1 88-2 883		84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 98	48-148-248-248-348-348-048-048-148-148-248-248-248-350-050-0	602 602 603 603 610 610 61-1 61-1 61-2 61-2 61-3 620 620 620 621 621 622 623 623 63	76-0 76-1 76-2 76-2 76-3 77-0 77-1 77-2 77-3 77-3 78-0 78-1 78-1 78-2 78-3 78-3 78-0	95-3 960,96-1,96-1,962,96-3,97-0,97-1,97-2,97-3,98-0,98-1,98-2,98-3,98-0,99-0,99-1,99-2,99-3	
75	48-3	120	289	87.2		92	1-64	039	780	1-86	
11	48.8	250	1-69	1:18		16	1.87	8-19	77.3	98-0	
40	48.2	25.0	1.69	0.18		90	0.67	249	77.3	97-3	
39	48-2	543	069	863		89	0-64	6/-2	772	37.5	
38	48-2	54.3	0.69	863		88	48-3	1-19	77-1	1-16	
37	48-1	545	8-89	862		87	48-8	1-19	11.1	0.16	
36	13-1	54.5	585	1-98		98	48-2	0-19	77.0	8-96	
35	480	1-49	1-89	0.98		85	48-2	0-19	891	395	
34	43.0	1-49	1-89	860		84	1-84	809	7.91	1-96	4
33	48-0	1-49	0.89	85-8		83	1-87	603	7.92	1-96	
32	423	54.0	673	85-2		82 83	48-0 48-1 48-1	209	1.91	0.96	
18	428	53.3	673	1-58		18	480	209	76-0	829	
		53-3	2-19	850			473	1-09	753	2-96	
29	49.5	53-2	87.5	843	-	279	47.3	1-00	75-3	1-96	
88	42.5	53-2	149	843		78	472	009	7.2-5	950	
24 25 26 27 28 29 30	1-34	23-7	019	84.2		74 75 76 77 78 79 80	47-8	59-3	74-3 75-0 75-0 75-1 75-2 75-3 75-3	84-8	
98	42-1	1-83	0-19	84-1	: :-	91	1-1.1	59-2	0.92	942	
25	42.1	530	<i>Ç-99</i>	1-158	-	91	47-1	285	0-92	34-2	
24	42-0 42-1 42-1 42-1 42-9 42-9 42-9	53-0 53-0 53-1 53-1 53-2 53-2 53-3	66-3 66-3 67-0 67-0 67-1 67-2 67-2	84-0 84-1 84-1 84-2 843 843		74	47-1 47-1 47-1 47-2 47-2 47-3 47-3	59-2 592 59-2 59-3 60-4 60-1 60-1	74-3	34-1 34-2 34-2 34-3 35-0 35-1 35-2	

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		<i>t-66</i>	1-66	066	0-66	886	Z86	1-86	0-86	<i>E-L6</i>	<i>3:46</i>	1-16	0-16	8.98	<i>296</i>	1-96	1-96	096	896	Z-Q6	1-96	O-CE	C-BR	7.46	Z-#6	1-51
	1-6%	064	882	8-8L	684	1.87	1.8%	V84	844	8:24	344	1-22	1-11	04.1.	69%	7-91.	7.01	1-01	1201	CCI	001	701	101	0.00	-	1
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g	0-09	0.09	8-67	8-67	<i>7.67</i>	<i>6.61</i>	<i>3.6⊅</i>	1.60	1.60	0-67	0-6Þ	8.Bt	8-81	Z-87	Z-8 <i>t</i>	1-8#	1-80	1-84	0.RT	E-L.P	8-17	310	3.1.0	1-10	1-1#	1-/#
tig. 3a	66	86	16	96	96	16	86	<i>76</i>	16	06	68	88	78	98	<u>G</u> g	18	68	<i>38</i>	18	08		<i>8L</i>	_	91		
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	068	€-88	Z-88	1-88	0.88	0-88	£-18	Z-L8	1:18	0:18	£98	<i>€98</i>	7.98	1-98	0.98	0.98	<i>8</i> -58	Z-G8	/ <i>-</i> G8	058	848	848	Z-178	1-1/8	1.118	0.48
	8.0Z	6-0L	1-0L	OOL	O-OL	869	<i>3:69</i> [Z69	1-69	1.69	069	0.69	8-89	z.89	1.89	1-89	0.00	6.10	8/0	7-/0	z-/0	140	0./0	0.10	000	0.00
	1.99	0.99	0.99	$\mathcal{C}\mathcal{G}$	699	6.55	1.55	1.55	099	0.55	879	8 <i>7G</i>	<i>7.79</i>	6.DC	<i>I-t</i> G	1-0G	1-10	n-tC	c.ca	c.ee	7.00	7.00	1.00	100	000	0.00
	677	677	1-77	1-77	UTT	044	0.77	8.87	8.81	7 <i>81</i> 7	7.8p	Z-8Þ	1-87	/-EP	98T	J.&Þ	0.80	83#	8 <i>7</i> 7	33Þ	Z-3#	7 <i>75</i>	134	1-84	1-317	0-77
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♦ 1340	0-116	8.86	<i>3:88</i>	1-86	0.86	0-86	836	8-36	1-36	036	8-16	Z-16	Z-16	1-16	0-16	cas	206	1.06	LOS	n.ne	cea	7.50		1.00		·
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\$4551 \$	3-11.	1-11	012	0-11/	8.8%	E-EZ	8-8L	Z8L	1-8L	1-61,	0-84	8-81.	<i>8-31</i>	Z-8L	1.87	0-3L	0-3L	E-14	E-/L	Z-1L	I-IL	0-14	0-11.	€:0 <u>/</u> .	8	
SHEET 4	Z-VL. -69	1-11L 1-69	0 tZ 0 69	0-11L 0-6G	8-8 <u>5</u>	&&Z &&G	8-8L 8-8L	Z&L !-8G	1-8L 1-8G	1-8L, 0-8G	0-8L 0-8G	&&1. &LG	8-3L 8-LG	Z-ZL Z-LG	1-3L 1-L9	03L 1:LG	0-3L 0-LG	&-1 <u>L</u> 0-LG	&-1L &9G	7-1L &9G	1-1L Z:9G	0-1L Z9G	0-11. 1-9G	8:0L	8	,
SHEET 4	Z-VL. -69	1-11L 1-69	0+12 0+69 8,9†	0-11 0-6G 8-9V	& & Z & & G & & G	&&Z &&G &&G	8-81 3-85 3-94	ZEL -8G -9V	1-8L 1-8G 1-9V	1-81. 0-89 0-94	0-8L 0-8G 0-9H	8-61. 84.G 8.GP	8-3L 8-LG 8-GV	Z-ZL Z-LG &-SV	1-3L 1-L9 3-GH	0-3L 1-LG 7-ST	0-3L 0-LG 1-Str	&-14 0-LG 1-Str	8-1L 8-95 1-91	7-1L &9G O-Str.	1-1L Z:9G 0:Str	0-1L Z9G 8-VV	0-11. 1-9G 8-111	8:01. 1:99 Z-04	8	,
I.C.	Z-VL. -69	1-12 1-69 0:Lt	0+12 0+69 8,9†	0-11 0-6G 8-9V	& & Z & & G & & G	&&Z &&G	8-81 3-85 3-94	ZEL -8G -9V	1-8L 1-8G 1-9V	1-81. 0-89 0-94	0-8L 0-8G 0-9H	8-61. 84.G 8.GP	8-3L 8-LG 8-GV	Z-ZL Z-LG &-SV	1-3L 1-L9 3-GH	0-3L 1-LG 7-ST	0-3L 0-LG 1-Str	&-14 0-LG 1-Str	8-1L 8-95 1-91	7-1L &9G O-Str.	1-1L Z:9G 0:Str	0-1L Z9G 8-VV	0-11. 1-9G 8-111	8:01. 1:99 Z-04	8	,
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The Barrer	2-11. 1-69 0-11 8/L 888	1-12 1-69 0-24 3L 3-88	0+11 0-69 8:94 1L 1-88	0-12 0-69 8-91 0L 1-88	&& && && & & & & & & & & & & & & & & &	888 89 89 88	8-61 7-85 7-94 1-9 7-7-8	zeL !-8G !-9V 99 z-z8	1-8L 1-8G 1-9V G9	1-81. 0-89 0-94 7-9 0-38	0-8L 0-8G 0-9t 89	818 818	8-3L 8-L9 8-9t 19 3-18	z-zL z-LG 8:SV 09	1-8L 1-L9 2-SV 6G 0-18	0-3L 1-LG 7-St 8-G 0-18	0-31 0-19 1-94 1-94 808	6-11. 0-LG 1-9tr 9 G 3-08	8-1L 8:99 1-91: 59	7-1L 899 0-9tr. TG	I-IL Z:99 0-9t EG 0-08	0-1L 2:99 8-VV 7-9 8-6L	0-11. 1-99 8-114 1.G	8:01. 1-99 Z-VV OG	8 4	} ,
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254,589 COMPLETE SPECIFICATION