Drawframe Draft

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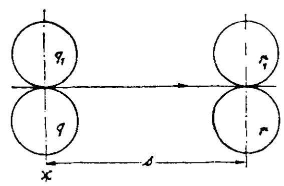
By draft is generally understood the drawing out or extension of slivers by means of suitable appliances whereby the average number of the fibres in the cross-section of the slubbing is reduced. If the cross-section of the sliver before drafting contains on an average Z fibres and after drafting Z_1, then realation is

$$\frac{Z}{Z_1} = v, \text{ the draft.} \qquad 1)$$

This result is attained technically by passing the sliver through two pairs of rollers $q\,q_1$ and $r\,r_1$, the second of which, the drawing rollers $r\,r_1$, have a speed which is v times greater than that of the first pair, the feeding

Fig. 1



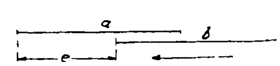
rollers $q\,q_1$ (see Figure 1). The distance s between the nips x and y of such a drawframe is adapted to the material and is so large that the longest fibres cannot be gripped by both pairs of rollers at the same time, as otherwise they would be torn by the action of the different speeds, or the draft would be disturbed.

The fibres move forward with the speed of the feeding rollers, about c, so long as they are in the nip of $q\,q_1$, but as soon as the tips of the fibres are caught by the nip of the drawing rollers $r\,r_1$, they move forward at the rate $v \times c$. In passing the draftframe the fibres thus have two consecutive rates of speed, namely from $q\,q_1$ the speed c and from $r\,r_1$ the speed $v \times c$. Usually the most of the fibres are not so long that their tips are caught by the drawing rollers just as their ends are being released by the feeding rollers, so that the change from one speed to the other follows directly. The shorter fibres, and that is the majority, after having been liberated by the feeding rollers, must pass over part of the path s free, before they are caught by the drawing rollers. At this stage the speed of the forward movement is purely a matter of chance. That is to say, if these short fibres are connected by friction or by interwining with fibres which have already been caught by $r\,r_1$, then they will proceed at the same velocity before their tips have reached $r\,r_1$. But if they are connected with such fibres as are still moving at the rate c of $q\,q_1$, then they will retain the speed c for a little while longer. On the other hand, if they are connected at both ends, their rate of speed will correspond to the result of the combination of both. The more irregular the staple is, the larger is the number of such fibres the speed of which is due to chance, but the greater also is the danger of an accumulation of fibres either forwards or backwards. In other words, the greater is the danger of producing an uneven, cut yarn.

Naturally attempts have all along been made to reduce the number of these chance movements as far as possible by building members everywhere between the two pairs of rollers where it could be done, the object of which was to compel the fibres to retain the speed c which they received from the feeding rollers until their tips reached the drawing rollers $r\,r_1$. It is not our intention here to investigate how far this ideal condition has been attained by constructors of machinery. The following observations, on the contrary, presume that it has actually been reached, so that it can be shown how drafting proceeds when all chance movements of the fibres to be drawn have been eliminated.

If two fibres a and b of a sliver (Figure 2a) pass through such an ideal drawframe, the relative position of the two fibres to one another suffers a change which is expressed by the distance between their tips becoming greater.

Fig. 2a

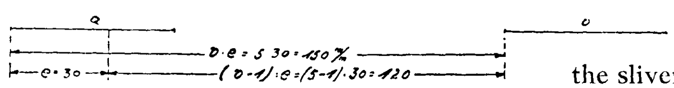


In Figure 2a the tip of the fibre a overlaps that of the fibre b in the direction of movement, indicated by the arrow, by the distance e. The two tips will retain this interval until the tip of the fibre a has been caught by the drawing rollers r r_1. From this moment on the fibre a moves with the speed v×c, while the fibre b retains the speed c until its tip has also been caught by the drawing rollers r r_1 that is, until it has covered the interval e. During this time t the fibre a covers a distance of v×c×t, and the fibre b the distance c×t.

Since c×t is equal to the distance of the tips e, the distance between the two tips e_1 after having passed the ideal drawframe with a draft of v is

2) $e_1 = e + (v \times c \times t) - (c \times t)$ from which follows $e_1 = v \times e$.

Fig. 2b



As soon as the tip of the fibre b has also been caught by the drawing rollers, the fibre b moves also with the speed v×c, and the distance between the two tips is not further reduced.

Let v = 5 and the distance between the two tips before drafting = 30 millimetres, then the distance between the two tips after drafting is 5×30 = 150 millimetres (Figure 2b).

What applies for these two fibres must also apply for all the other fibres of the sliver, so

Case A.

I Uniform length L of all fibres with identical thickness, and the same volume by weight, i. e. the staple is absolutely uniform.

II The same number of fibres z in every cross-section, i. e. the sliver is completely uniform.

III Uniform distribution of the fibre tips among the fibres of the sliver, i. e. the same distance from the tip of one fibre to the next.

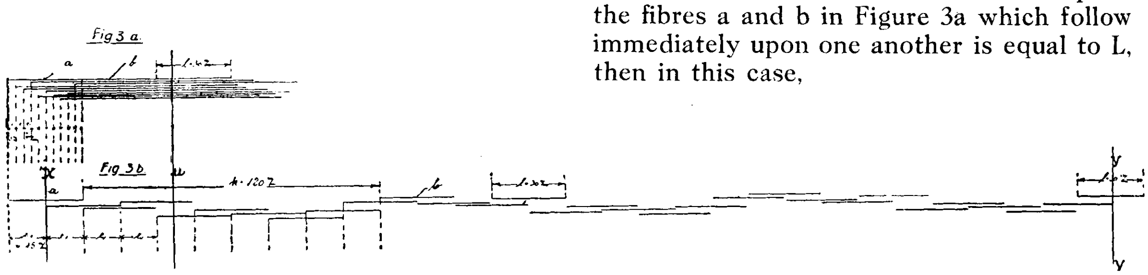
If L = 30 millimetres (length of the fibres), and z = 10 (number of fibres in the cross-section of the sliver) then according to hypothesis III the distance between the tips must be $e = \frac{L}{z} = 3$ millimetres. This sliver is diagramatically shown in Figure 3a in such a manner that the fibres of the sliver lying above and beside one another in a more or less elliptical cross-section are all straightened out in one plane beside one another. The ends and tips of the fibres are indicated by points.

By the drawing the distances e of the tips of the fibres from one another of this completely regular sliver in the ideal drawframe is raised according to formula 2) to

$$e_1 = e \times v = 3v$$

when v = 5, then e_1 = 15 millimetres (Figure 3b).

Since the distance between the fibre tips of the fibres a and b in Figure 3a which follow immediately upon one another is equal to L, then in this case,



Length of fibre after one draft v = 5

Fig. 3 b

that it can be said in general that in an ideal drawing frame the distance between the fibre tips must be v times greater, when v is the draft.

We have thus here the possibility of showing diagramatically the change which a sliver undergoes in passing through an ideal drawframe through the axial displacement of the fibres contained in it.

The graphical representation of the change of draft will now be shown in systematic development by a sliver under the following three hypotheses:

3) $$e_1 = v \times L.$$

Accordingly gaps k must occur between all the fibres of a sliver which follow directly after one another owing to the draft v, and the size of the gaps can be determined by the formula $k = e_1 - L$, or by the use of formula 3)

4) $$k = (v - 1)\ L.$$

According to formula 1) $v = \frac{z}{z_1}$ becomes $z_1 = \frac{z}{v}$,

if z = 10 and v = 5, then $z_1 = \frac{10}{5} = 2$.

In order to be able to represent diagramatically sliver with any number of fibres, it is simpler to think of the fibres of the sliver as being so ordered beside one another that those fibres, the tips of which are nearest to each other, lie together, and those fibres, the ends and tips of which fall in the same cross-section, that is to say which follow directly after one another, are made to lie behind one another upon a line. Then the sliver of Figure 3a appears as shown in Figure 3c, from which, as developed above, the Figure 3d of the sliver with a draft of 5 proceeds.

Lines connecting the tips of the fibres lying beside one another in Figure 3c must, according to hypothesis III, cross the axis of the sliver as straight lines at an acute angle and, according to hypothesis I (same length of all the fibre tips, as in Figure 4a, which were distributed over a length L, now fall upon one-third of the length L, while the rest of the fibres are distributed upon two-thirds of L, then all the tip lines assume a similar parabolic curved form.

If this sliver is again drawn with a draft = 5 in the ideal drawframe, then the drafted sliver, shown diagramatically in Figure 4b, is produced.

Between fibres a and b there is again a gap

$$k = (v - 1)L$$
$$= (5 - 1)30 = 120 \text{ millimetres.}$$

The distances between the tips eI eII eIII eIV eV are, according to the formulae

$e_1I = e \times v$, extended to
$e_1I = eI \times v$
$e_1II = eII \times v$
$e_1III = eIII \times v$ and so on.

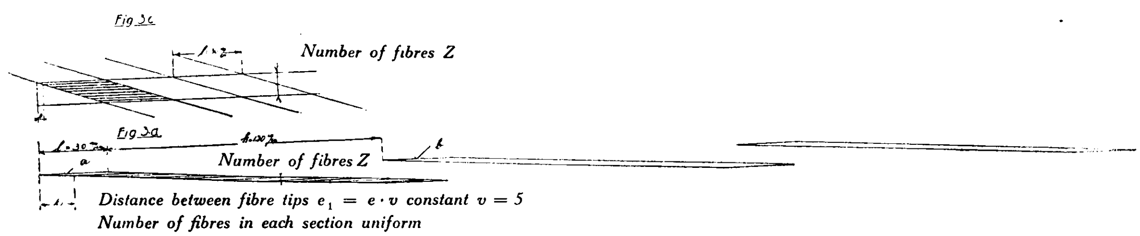


Fig. 3 c

fibre), must be parallel, as is also the case with the drafted sliver (Figure 3d).

The representation according to Figure 3c will always remain the same whether the number of the fibres z in the cross-sections is large or small. Merely the density will be changed by the presence of a larger or smaller amount of fibres z, in which the fibres are pictured as lying beside one another. The closer the position of the fibres, the more fibres are present in the cross-section, and the smaller is the distance between the fibre tips e.

In the following diagrams accordingly the single fibres are no longer represented, but surfaces evenly covered with fibres, the two-dimensional extension of the surfaces being no longer absolute, but merely expressing the relative number of fibres in the cross-section.

Case B

The three hypotheses of case A were still all valid for the sliver represented in Figure 3c. If hypothesis III is so altered that the distances between the tips of the fibres are no longer identical, but continually increase and decrease, so that, for example, three-fifths of

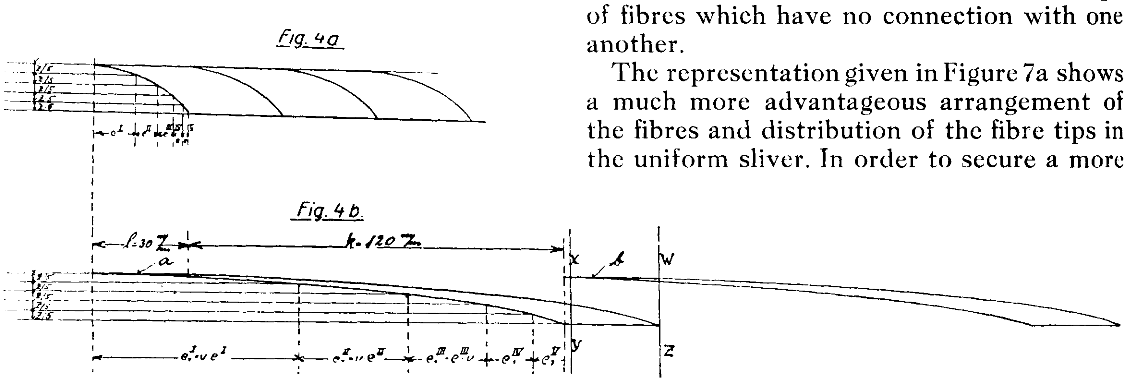
From Figure 4b it can be seen that hypothesis II as a condition for the uniformity of the sliver (identical number of fibres in all cross-sections), assumed for Figure 4a, no longer applies for drafted sliver. The bisecting line xy cuts about six times as many fibres as the line wz. The reduction of the number of fibres in the cross-section by the draft v proceeds still according the the formula $z^1 = \frac{Z}{V}$, but only for the average of all cross-sections, and no longer for each of them as in case A.

It follows from this that a uniform sliver composed of uniform fibres can only be drawn to a uniform yarn when the tips of the fibres lying in it are absolutely regularly distributed. If this is not so and the tips accumulate in heaps, *then even the ideal drawframe can only produce an irregular yarn*, however uniform the sliver worked upon may be.

There are no means known in practice of arranging the fibre tips; they are the subject of chance. But just as it cannot be assumed that chance arranges the fibres so that the tips lie as in Figure 3c, the contrary can as little be assumed that they lie in an absolutely unfavourable position as in Figure 4a. In practice constantly varying distances between the fibre tips must be reckoned with, which, however, are less marked the smaller the average distance is; that is to say, the more numerous the fibres in the cross-section of the yarn or sliver are.

of fibres of each length is present (staple diagram Figure 5). If a uniforms liver composed of this material passes through the ideal drawframe (Figure 6a) with a draft of 5, then something is produced which cannot be termed sliver, thread, or yarn (Figure 6b). Although the distances between the tips are uniform in the sliver, the draft has split up the mass of fibres in the drawframe into groups of fibres which have no connection with one another.

The representation given in Figure 7a shows a much more advantageous arrangement of the fibres and distribution of the fibre tips in the uniform sliver. In order to secure a more



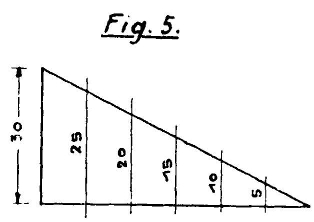
Distance between tips of fibres $e^I > e^{II} > e^{III} > e^{IV} > e^V$
Number of fibres at xy greater than in section at wz

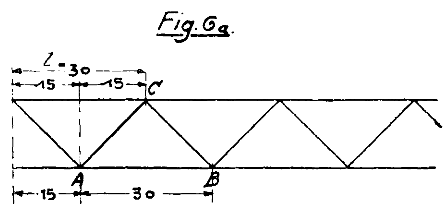
Fig. 4a

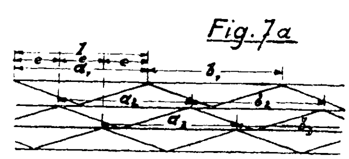
Case C

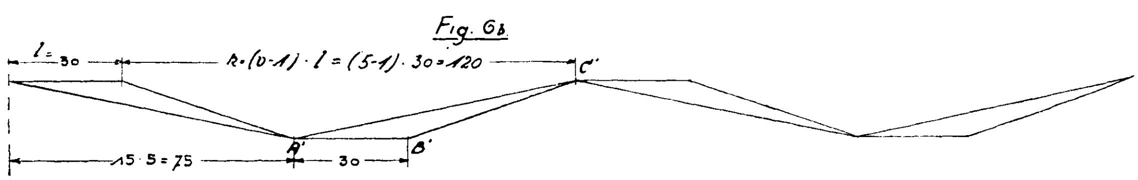
The following remarks refer to a sliver the fibres of which are not uniform, as in case A, hypothesis I, but vary from 0 to 30 millimetres, in such a way that an equal number

uniform draft, the sliver shown there is composed of three uniform single slivers according to Figure 6a in such a way that the one sliver is always axially displaced against the next by one-third L. By this means the thin









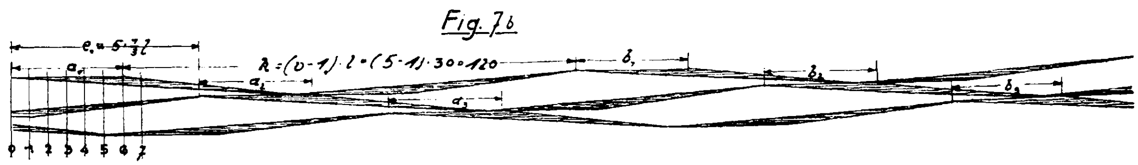


Fig. 8a.

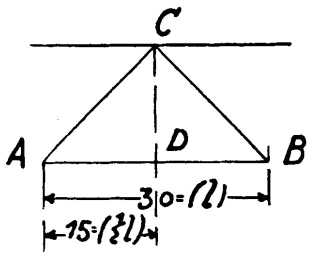
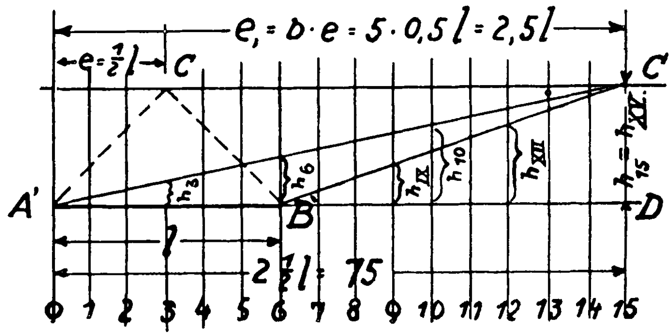


Fig. 8b.



and thick places of each sliver hide one another when being drafted. The yarn produced in this way can be pronounced very good in quality as the following proportional figures show which have been calculated from the fibres in Figure 7 b cut across by the lines 0, 1, 2, and so on.

In the Figure 8 b used for the calculation, the triangle A'B'C' represents the triangle ABC of Figures 6a and 8a which has been displaced by draft 5. Now since the triangle A'B'C' is the surface covered with fibres, the difference of the height of these two triangles A'DC' and B'DC' gives the proportional figures of the fibres which can be cut by any number of sections at right angles to the base line A'D.

If $A'D = 2.5 \times L$ (from $e_1 = 5 \times e - 5 \times \frac{L}{2} = 75$), then the proportional figures of the fibres cut by the section lines in Figure 8 b are, for example:

For section line : 0 = 0

" " " : 1 = 0.0667

from $\frac{h_1}{h_{15}} = \frac{0.1666 \times L}{2 5 \times L}$, therefore $h_{15} = 1$, $h_1 = 0.0666$.

for section line	:	2 =	0.1333
" " "	:	3 =	0.2
" " "	:	4 =	0.2667
" " "	:	5 =	0.333
" " "	:	6 =	0.4
" " "	:	7 =	0.3555
" " "	:	8 =	0.3111
" " "	:	9 =	0.2667
" " "	:	10 =	0.2222
" " "	:	11 =	0.1778
" " "	:	12 =	0.1333
" " "	:	13 =	0.0885
" " "	:	14 =	0.0444
" " "	:	15 =	0

Transferred to Figure 7b, we get the proportional figures of all the fibres cut across in the three single slivers from the sum of the proportional figures of each of the three slivers. When section lines 0, 1, 2, 3, and so on are again plotted at intervals of one-sixth L, these amount to:

for section line	: 0 = 0 + 0.333 + 0.222 =	0.555
" " "	: 1 = 0.0667 + 0.4 + 0.1778 =	0.614
" " "	: 2 =	0.622
" " "	: 3 =	0.6
" " "	: 4 =	0.578
" " "	: 5 =	0.555
" " "	: 6 =	0.644
" " "	: 7 =	0.622

and so on.

Thus the proportion of the fibres in the thinnest parts of the whole of the drafted sliver to the fibres in the thickest parts in the above case is, for instance, as 55.5 to 64.4. A yarn with such proportional figures for the cross-sections of the thickest and thinnest parts (the fibres being regarded as uniformly thick) deserves to be termed practically uniform.

The above considerations lead to the conclusion that the drafting is more uniform the more single slivers in the sense of Figure 7 b are taken to make up the sliver to be drafted, that is to say, the more possibilities there are of adjustment of differences.

In order to secure an absolutely regular draft, the sliver would evidently have to be composed of as many single slivers as the material to be spun contains different lenghts.

Suppose that material to be spun consists of fibres of 5 millimetres length, increasing by 5 millimetres to 30 millimetres, than the uniform sliver would contain 6 slivers arranged as in Figure 6a, corresponding to the 6 length groups, which would have to be so disposed among each other that each lay 5 millimetres behind the next one.

Figure 9a is a diagramatic representation of such a sliver. If the fibres of each length group in this Figure are removed and laid beside one another, taking care not to displace them axially, then the sliver falls, as shown in Figure 9b, into six separate slivers each of which contains only fibres of one and the same length group, which are arranged with uniform intervals between the tips, just as in Figure 3c. Since the draft of each single sliver proceeds uniformly according to Figure 3c, provided that the number of fibres in the cross-section of each sliver can be divided without remainder by v, it follows that the whole of the sliver must be regularly drafted. In this case it is of no moment how the single slivers lie axially to one another.

When it was said in discussing Figure 4b that a sliver of uniformly long fibres can be more uniformly drafted the more numerous the fibres in the cross-section, the same principle must apply for every other sliver. Every sliver composed of fibres of different length, as shown above, can be regarded as a collection of a number of slivers each with uniformly long fibres, whereby the fibres may be more or less numerous in the cross-section of each separate sliver according to the course of the tip curve in the staple diagram. If the number of fibres in the cross-section of the sliver as a whole increases, it increases also in the cross-section of each single sliver, whereby the uniformity not only of each sliver, but of the whole sliver is improved.

Fig. 9a.

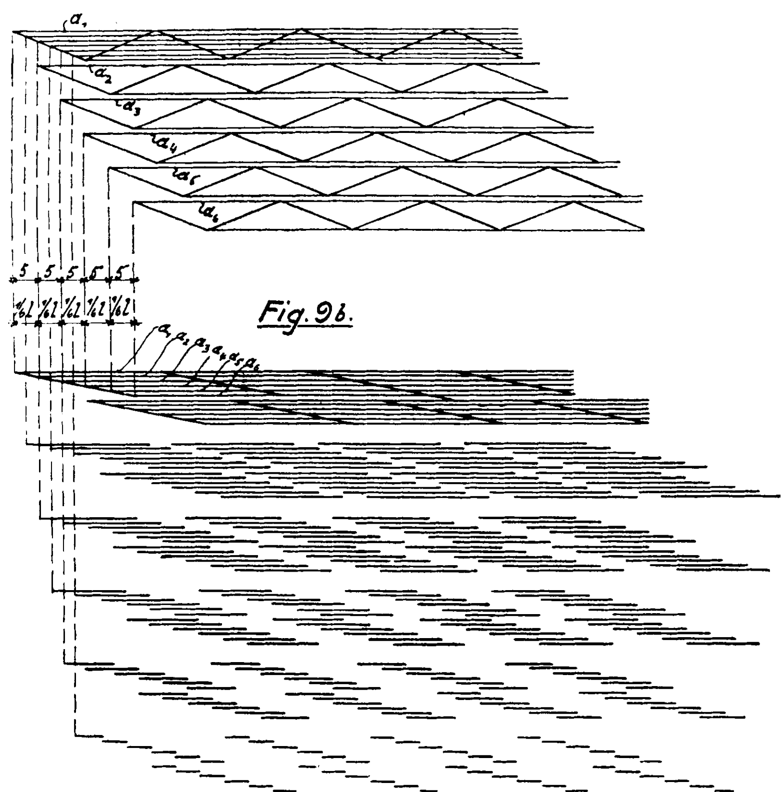


Fig 9 a und 9 b :
Sliver composed of six single slivers with fibres of 5, 10, 15, 20, 25 and 30 millimetres in length and total of 42 fibres in cross-section

If the fibres of one of these six single slivers were arranged according to Figure 4a, then these single slivers would be unevenly distributed according to Figure 4b and impair as a whole the uniformity of the yarn to be spun, the damage being greater the larger the proportion of the fibres of this single sliver, by percentage of weight and numerically, to the total number of fibres.

Since the fibres of each length group in the sliver according to Figure 9a are numerically the same, the share of the length groups by weight must be proportional to the length of the fibres, so that, for example, for the 30 millimetre long fibres it would be six times as great as for the 5 millimetre fibres. An irregular distribution of the fibre tips in the single sliver with the 30 millimetre fibres would therefore act more unfavourably on the uniformity as a whole than that of every other single sliver. For this reason it is desirable that the length group which has the greatest share by weight in a sliver also contains the most fibres, that is to say, that the tip curve of a staple diagram should run as convex as possible and remain longest at one height where the longest fibres are.

Of course it might be thought that uniformity could be attained by irregularities of the single slivers adjusting or cancelling themselves. But even so the extent of the adjustment is again dependent upon the number of possibilities of adjustment, that is, upon the number of fibres in the cross-section, a phenomenon which may be shortly designated a function of plurality. This function of plurality is the counteraction of chance, that is of the chance occurrence of only unfavourable moments. The principle can be recognized everywhere by its action in reducing errors or in hindering action where final figures are found from a number of average values or where average values are calculated from a number of single values. It is the function upon the basis of which multiplication is carried out.