CALCULATION OF CHANGES IN THE YARN DEMAND OF LOOP FORMATION ON WARP KNITTING MACHINES

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1. Introduction

During the cycle of loop formation on warp knitting machines — according to the manner of its realization — the length of yarn section between the fabric produced and the tension bar changes persistently, responsible for variations in yarn tension, displacement of the tension bar, a fact permitting — on suitable knitting machines — the control of yarn supply.

Variation in yarn demand between the fabric and the tension bar results from the interaction of the knitting elements, i.e. the construction and setting of the knitting machine, furthermore the lapping movement, i.e. fabric structure. It follows that knowing the changes in yarn demand, the possibility of studying in detail the loop formation process is given, particularly if the relative positions of the yarn sections involved and those of the knitting elements in the different phases of the knitting process can be determined for the purpose of calculating the yarn demand. In addition, there is a possibility for the

— constructional comparison between warp knitting machines of different types and those produced by different makes,

— choice of optimum machine settings for designing fabrics of required structure,

— analyse of the knittability of yarns of different properties and the determination how to modify machine settings.

The latter is rendered possible by the close relation between theoretical yarn demand and tension bar displacement due to changes in yarn tension. The mechanical properties (friction, extension, elasticity a.s.o.) of the yarn to be knitted are, of course, of decisive importance in this respect.

2. Method of calculation

2.1 *Principle*

Making use in a spatial co-ordinate system with the help of the diagrams of the movement of the knitting elements and of their momentary relative positions to one another in the loop formation process (Fig. 1 needle in bottom dead point position) let us determine the displacement of a given point of the loops contacting the yarn, in a spatial co-ordinate system.

During loop formation the yarn between the last loop and the tension bar consists of sections of varying number and length. Accordingly, sectioning the cycle of knitting, yarn demand can be calculated for the phases concerned, i.e. for points assumed at adequate densities (in our case for points corresponding to 10° angles of revolution of the main shaft).

In the calculation theoretical and actual yarn path can be distinguished. For determining theoretical yarn demand the tension bar is assumed as immobil (fixed). Actually, however, variation in the path length of the yarn is

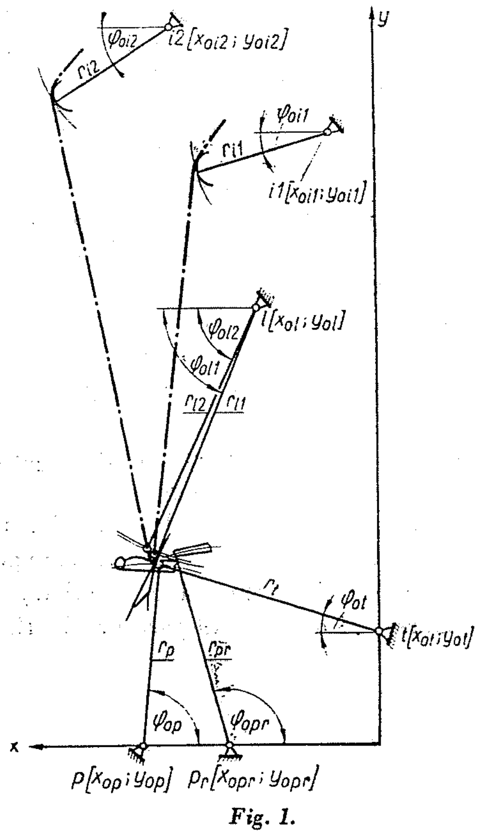

Fig. 1.

taken up partly by the deformation of the yarn, partly by the displacement of the tension bar (the latter depending on yarn tension). Taking into consideration the displacement of the tension bar in the calculation means, to renounce of static analysis for following the actual yarn path resulting from the interaction of the changes in the theoretical yarn demand of loop formation, yarn properties and yarn supply consistent with the corresponding phases of the knitting process actually dependent on yarn tension.

Both theoretical and actual yarn path will be determined for conclu dinl from their difference and from yarn properties on knitting conditions.

2.2 *Approximative assumptions*

In our calculations the following neglectes will be made (for further loca simplifications applied, see the calculation sections concerned).

- The friction between the yarn and the contacting surface of the knitting elements, i.e. the slight displacement of the loop caused by the movement of the needle will be omitted. The distance between the sinker and the neddle center line is of the 0.5 mm order, even on assuming a high coefficient of friction, prevents the loops lying on the needle from moving off the plane of the fabric fixed by the clamping points of the sinkers.)
- The slight excentricity of the free yarn end from the center line of the needle in the direction of the movement of the guide within the range permitted by the dimensions of the loop produced will be ignored. (The sinker loop leading to the next loop is formed by the yarn section beginning at that point.) The error in yarn demand resulting from this assumption is of no significance.
- The widths of the yarn and of the knitting elements is omitted. (When knitting thick yarns on coarser gauge machines, calculation has to be modified accordingly.)
- In the determination of theoretical yarn path the individual yarn sections are assumed to be rigid bodies, suffering negligible deformation upon tensions occurring in the knitting cycle. The actual yarn demand is calculated from an initial value based on a similar principle and the extension of the yarn in the individual yarn sections will be determined from empirical correction factors.
- The yarn quantity contained in the loop is assumed to be constant, neglecting its effect on the change in yarn demand, i.e. the yarn length slipped back from the loop. This is justified by the effect of fabric draw-off and by the reaction of the eventual variation in loop size during loop formation on the preceding loops.
- The yarn considered is assumed to lye on the tension bar in the bisecting

plane of two (adjacent) needles, perpendicular to the needle bar and surrounding the yarn at the start of loop formation. This is exactly the case for the lapping movement according to the example described and for a correct machine setting. With different lapping movement instructions, conditions may differ, displacements of one or two needle spaces in the location of the yarn on the tension bar are, however, irrelevant, compared to the considerable distance between the guide and the tension bar.

— The displacement of the contact point between the yarn and the guide due to the lapping movement of the guide bar will be neglected. As contact point, the bottom point of the bore in the vertical position of the guide, is considered with no significant error.
— Similar neglect is made for the lying-on point of the yarn on to the tension bar.
— In contrast to assumptions made in similar experiments described in literature, in our calculation the change in yarn demand after the last loop on the needle stem had been knitted, is neglected. On the contrary, the displacement of the knitting elements along an arc, the height of the needle hook, the effect of pressing and that of the lapping movement of the guide will be considered, the more so as it permits to compare the yarn demand of fabric constructions produced with different lapping movements.
— The example considered refers to closed lap tricot structure of one needle space for which — because of symmetry — the investigation of a single knitting cycle suffices. For more complicated lapping movements data and calculation have to cover the total height of the design unit, and for all guide bars.

2.3 *Calculation*

Location of knitting elements and tension bars

Use will be made of the following relationships (see Fig. 1)

$$x = x_0 \pm r \cos (\varphi_0 + \varphi),$$
$$y = y_0 \pm r \sin (\varphi_0 + \varphi),$$

where x_0 — co-ordinate x of the rotation axis,

y_0 — co-ordinate y of the rotation axis,

r — length of radius at the distinguished point,

φ_0 — angle included between the radius at the distinguished point assigned and the axis x when the needle is in its bottom dead point position,

φ — angle of displacement during loop formation as compared to φ_0.

(Other subscripts in Fig. 1 refer to the knitting element concerned.)

The sign to be applied is defined by the relative position of the rotation axis of the knitting element involved and its distinguished point. The origin of the axis z of the co-ordinate system is assumed so that — in the case of tricot lapping movement of one needle space — the full lapping movement is in the positive zone. Accordingly, the symmetry line of the loop as the initial point of the investigated yarn is in a plane xy spaced of 2 needle spacings from the origin.

First phase of the loop formation process (raising the needle, beginning of the lapping movement)

The needle is raised, the guide swings to behind the needle and starts to perform its overlapping movement, then swings back.

The position of the last loop on the needle in directions x and y (Fig. 2) is approximately determined by the position of the sinker throat T fixing the plane of the fabric with the help of the sinker loops produced. Owing to the reversed, thus symmetric lapping movement of identical needle space, the loop formed by the two yarns in direction z is perpendicular to the plane of the needle bar, hence its co-ordinate approximately coincides with that of the needle.

Resulting point p will be considered as the initial point of the free yarn section (following the last loop knitted), and yarn demand will be calculated from this point on.

Since in this phase of the knitting process the yarn section lying between the initial point and the point of contact with the guide is free from inflexion on the needle to be lapped over, its length can be calculated as a straight yarn section. Similarly, the yarn section between the guide and the tension bar is

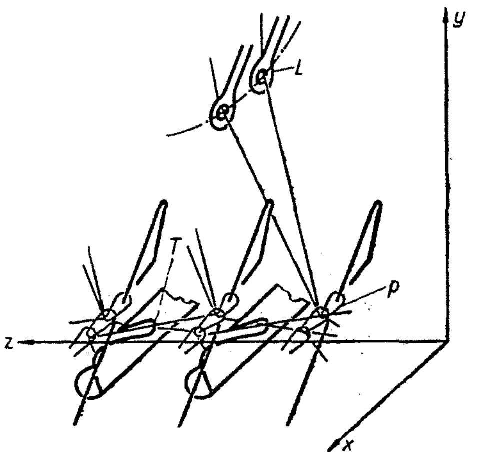

Fig. 2.

a straight yarn length. Thus, the resultant yarn length can be calculated — separately for the two guide bars — as a function of the momentary positions of their lying on points, by means of the following relationship:

$$d_l = [(x_l - x_p)^2 + (y_l - y_p)^2 + (z_l - z_t)^2]^{\frac{1}{2}} + [(x_i - x_l)^{\frac{1}{2}} + (y_i - y_l)^2 + (z_i - z_l)^2]^{\frac{1}{2}},$$

where

x_l, y_l, z_l — co-ordinates of the point of contact (L in Fig. 2) between the guide and the yarn (see also Fig. 5)

x_p, y_p — co-ordinates of the distinguished point T of the sinker

$z_t = 2t$ — co-ordinate of the needle at the initial point of the yarn investigated (t — needle spacing in mm)

x_i, y_i, z_i — co-ordinates of a distinguished point of the tension bar (in conformity with the assumptions, $z_i = 2.5\ t$).

(On the basis of the approximations applied, the position of the initial point of the yarn is given by x_p, y_p, z_t.)

As the two yarn systems forming the tricot construction do not follow the same path, calculation is carried out for the two yarns separately. Thereby the effect of the relative positions and of deviations in movements of the guide bars can be clearly revealed.

The first phase of the knitting process is being completed when the yarn section extended up to the guide attains the needle to be surrounded by it (Fig. 3). From then, the part of yarn to the guide can be defined and has to be calculated as the sum of two straight yarn sections. (The yarn passes between the points ABD instead of AC marked in the top view of Fig. 5.)

Determination of the limit position, i.e. time and point of contact (between the yarn and the needle, both moving as evasive straight lines)

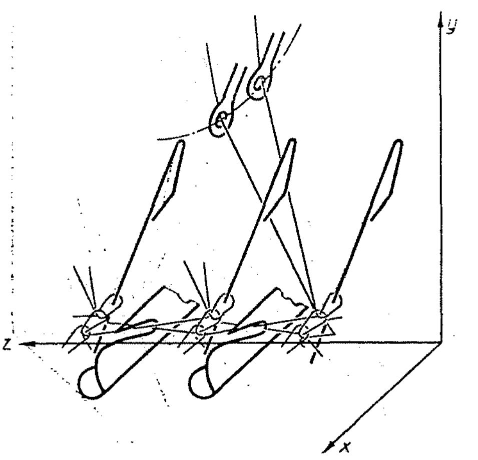

Fig. 3.

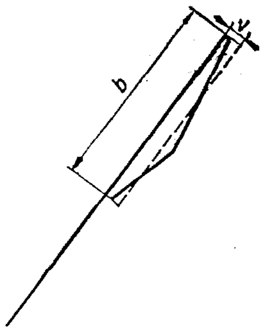

Fig. 4.

is substantially facilitated by using a computer. Mathematically, the limit condition can be formulated by defining that point B of the yarn at any time falling in the plane xy containing the needle concerned, and then determine the value of that point which satisfies the equation of the needle considered as a straight line for the corresponding momentary position.

Contact between the yarn and the needle generally takes place in the needle hook, or in extreme cases it may also occur along the needle stem, hence, let us consider the possible cases separately.

If the co-ordinate y of the yarn point falling in the plane of the needle is found in the height zone determined by the needle hook, the equation of the needle hook, otherwise that of the needle stem will be applied. (The needle hook is approximated by the straight section parallel to, and at a distance v from the needle stem, as shown in Fig. 4.)

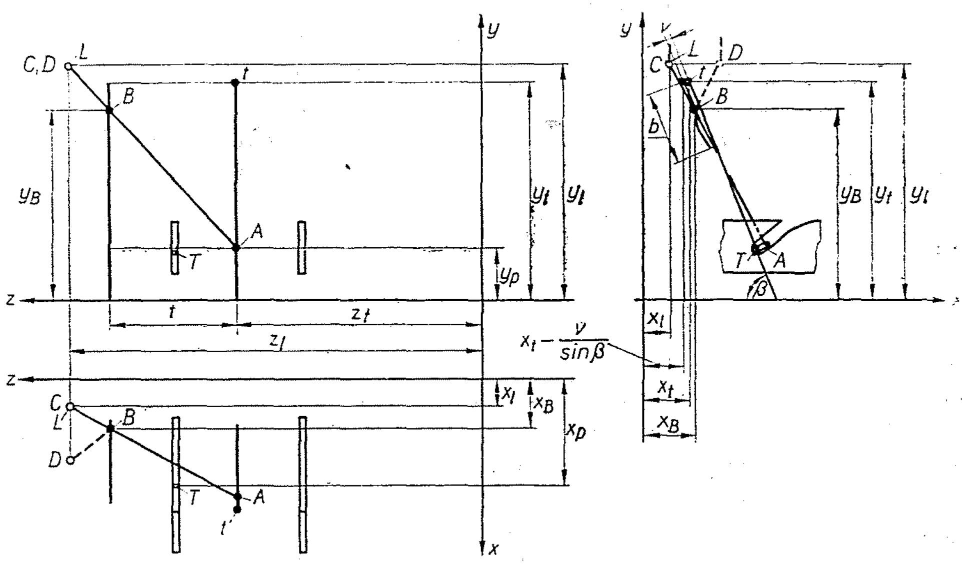

Fig. 5.

Accordingly, co-ordinates x_B, y_B, z_B of point B are:
using the plane projection xz (Fig. 5):

$$x_B = x_p + \frac{x_l - x_p}{z_l - z_t} t;$$

and the plane projection yz

$$y_B = y_p + \frac{y_l - y_p}{z_l - z_t} t;$$

$$z_B = z_t + t;$$

with notations as above (subscript t refers to the co-ordinates of the needle).

In the case of contact, the co-ordinates of the running point B satisfy the equation of the needle stem shown on the projection xy

$$y - y_t = \tan \beta (x - x_t)$$

for

$$y_B < y_t - b \sin \beta$$

or the equation of the needle hook,

$$y - y_t = \tan \beta \left[x - \left(x_t - \frac{v}{\sin \beta} \right) \right]$$

for

$$y_t \geqq y_B \geqq y_t - b \sin \beta$$

where

b and v — main dimensions of the approximated needle hook, as indicated in Fig. 4,

β — angle included between needle stem and the plane xz, of negligible variation during this short period of the needle motion.

Thus, if the limit condition is met point B (x_B, y_B, z_B) is ruled by the equalities

$$y_B = y_t - \tan \beta (x_B - x_t)$$

and

$$y_B = y_t - \tan \beta \left[x_B - \left(x_t - \frac{v}{\sin \beta} \right) \right]$$

respectively,
is valid (for the two yarn systems in different positions).

Considering that no calculation can be made but for discrete points, no a break in the yarn path can be expected at time involved in calculation. For the intersection of yarn path and needle not even a limit of tolerance can be given (with a too wide range of tolerance too early contacting, while with a too narrow range no solution at all will be obtained for the point calculated).

No such uncertainty prevails, however, when direction factors of yarn point B (in the needle plane) and that of the straight line determined by the needle tip t are compared with the direction factor ($\tan \beta$) of the needle (considered as a straight line) at the moment given, because from the moment of contact, the relation of the two direction factors is changed. Since in the phase of loop formation concerned, point B is behind the needle (between the thick line of the straight part of the needle and the axis y in Fig. 6) the straight line tB is steeper prior to contacting, then — when point B is beyond the straight part of the needle, — it becomes less steep than the straight part of the needle. Thus, calculation involves the broken yarn path from the first

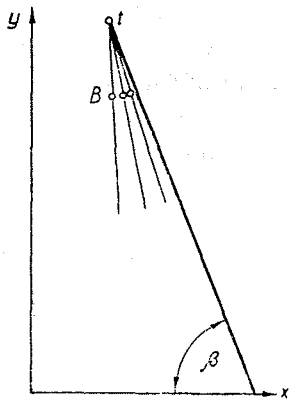

Fig. 6.

appearance of the condition

$$\left| \frac{y_B - y_t}{x_B - x_t} \right| < \tan \beta,$$

or — assuming the contact to occur at the needle hook, —

$$\left| \frac{y_B - y_t}{x_B - \left(x_t - \dfrac{v}{\sin \beta} \right)} \right| < \tan \beta.$$

As in the previous phase of loop formation, when the guide is just swinging to behind the plane of the needle — the former relationship may hold for a fictive point along the extension of the yarn path, it seems to be advisable to stipulate that, when parallel to the plane of the needle bar, the guide concerned will to have passed already the needle involved:

$$z_1 > z_B.$$

The simultaneous applicationed both conditions makes the calculation of the contact limit point unambiguous.

Second phase of the loop formation process (completion of the lapping movement, landing of the loop prior to pressing)

The guide bars complete their swinging motion, the needle is raised to its upper dead point position and starts to sink. When lapping is made on the hook, during the rise of the needle the yarn slips from the neede hook over to the needle stem and surrounds it. (At this moment the yarn length required suddenly decreases which has to be taken into consideration.)

In that phase on the position of the initial point of the yarn is inaffected by the movement of the needle because the loop does not move together with the needle. The yarn part concerned is the sum of three yarn sections (that between the initial point and the needle surrounded by the yarn, that between the needle and the guide and that between the guide and the tension bar).

Neglecting the coefficient of friction as a first approximation, it has been assumed that the yarn path is broken on the needle of an unchanged angle between yarn sections before and after the contact point included with the plane xz remains unchanged (as if the two yarn sections would be joined in the same plane with identical direction factor).

Thereby an equation of higher order is obtained for the explicite representation of the co-ordinates to be solved by some approximative method. In view of the neglects already involved for the above, difficult relationship (not even the result of the calculation is quite exact), furthermore considering that the slight displacement of the breaking point hardly affects the sum of adjacent yarn lengths, for facilitating the calculation technique it appears expedient to assume a constant position of the breaking point as being from the moment of contact between the yarn and the needle. Accordingly, the co-ordinates of the breaking point agree with those of the contact point B determined previously for the limit case. Hence in the second phase of the loop formation process for the yarn length we may write

$$d_{II} = [(x_B - x_p)^2 + (y_B - y_p)^2 + (z_B - z_t)^2]^{\frac{1}{2}} + [(x_l - x_B)^2 + (y_l - y_B)^2 + (z_l - z_B)^2]^{\frac{1}{2}} + [(x_i - x_l)^2 + (y_i - y_l)^2 + (z_i - z_l)^2]^{\frac{1}{2}},$$

where

x_B and y_B — calculated values for the limit case of the first phase, $z_B = 3t$, hence $z_B - z_t = t$, a yarn section between two adjacent needles being involved.

Third phase of the loop formation process (pressing, knocking-over)

During the period of pressing the needle bending out flexibly its hook is not in the position required by the law of movement of the needle bar, but in that determined by the presser. The old lopp slips from the needle stem over to the needle hook.

Due to the effect of pressing the needle bends out to an extent that — at a fair approximation — the hook takes the place occupied by the needle stem in absence of pressing (Fig. 7), as seen on photographs taken of the process of pressing.

A further deviation compared to the phases considered above is that at the corresponding moment of loop formation the fabric is not any more held by the sinker throat but it slips on to the sinker profile because of the displacement of the sinker nearly perpendicularly to the plane of the needle bar.

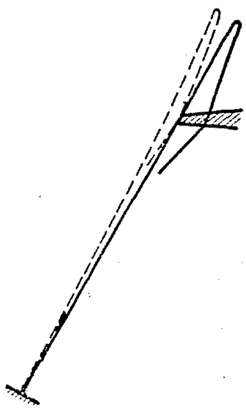

Fig. 7.

Pressing begins with the contact of the needle hook and the presser. Presser edge co-ordinates x, y satisfy the equation of the needle hook:

$$y_{pr} = y_t - \tan\beta\left[x_{pr} - \left(x_t - \frac{v}{\sin\beta}\right)\right] \tag{1}$$

Once this limit case prevails, the contact point of the needle and the old loop can be approximately defined from the following consideration:

In this case, the co-ordinate y with respect to the old loop is obtained from the lying on height of the fabric on the sinker profile, obtained, in turn, from knowing the form of the sinker applied. Assuming the relative positions r_M and ε of the throat point T and of the maximum point of the vault (M in Fig. 8) as before, the co-ordinate y of the contact point of the sinker and the fabric can be approximatively calculated by a relationship, where the radius increment Δr at each point of the sinker profile between its points T and M is substituted by a sine curve.

In the forward dead point position of the sinker (for instance at 180° revolution of the main shaft, when the sinker is obviously in the range of its position of rest) the co-ordinate y of the throat point contacting the yarn (T_h in Fig. 9) is obtained from the relationship:

$$y_p = y_{0p} + r_p \sin(\varphi_{0p} + \varphi_{18p})$$

where

- y_{0p} — co-ordinate y of the rotation axis of the sinker,
- r_p — radius of the arc drawn through point T from the centre of rotation,
- φ_{0p} — angle included between the radius at point T and the axis x at the beginning of the knitting cycle (at a 0° revolution of the main shaft),
- φ_{18p} — change in the above angle φ_{0p}, at a 180° revolution of the main shaft.

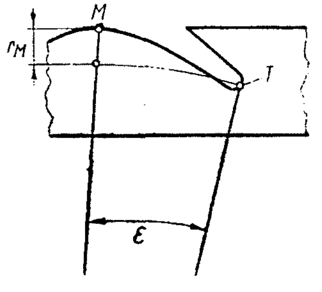

Fig. 8.

Assuming that after the sinker rotates by angle γ the fabric will lie on point G of the sinker belonging to the same angle φ as previously, the expression defining its co-ordinate y will only be modified by adding to r_p the radius increment Δr resulting from sinker profile and corresponding to the angle of displacement from the dead point position (see Fig. 9):

$$y_G = y_{0p} + (r_p + \Delta_r) \sin (\varphi_{0p} + \varphi_{18p})$$

where

- Δr — the value of the sinker profile for a displacement γ of the sinker to be calculated from the sine curve.

An angle of displacement ε is concomitant to a full radius increment r_M between points T and M corresponding to 90° in the sine function substituting the profile curve. Hence, in the range of interpretation of the sine curve the angle

$$\delta = \frac{90\gamma}{\varepsilon}$$

pertains to the displacement γ at the tested moment. Thus

$$\Delta r = r_m \sin \delta,$$

hence

$$\Delta r = r_M \sin \frac{90\gamma}{\varepsilon}$$

to yield:

$$y_G = y_{0p} + \left(r_p + r_M \sin \frac{90\gamma}{\varepsilon}\right) \sin (\varphi_{0p} + \varphi_{18p}).$$

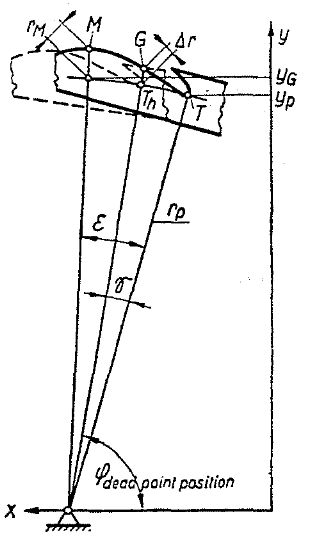

Fig. 9.

Similarly, the co-ordinate x of point G can be defined as:

$$x_G = x_{0p} - \left(r_p + r_M \sin \frac{90\gamma}{\varepsilon}\right) \cos (\varphi_{0p} + \varphi_{18p}).$$

Since the old loop lies on the needle stem at a height determined by the sinker profile calculated above, the correctness of the approximation applied can already be controlled during the calculation. The approximation method can be considered as acceptable for instance when the co-ordinates x of the contact point of the sinker and that of the point of the needle stem contacting the loop shows a deviate by less than the value of the loop height increased by a term to attain the required accuracy. Point x_g of the needle is obtained from the equation of the needle stem at the height of point G

$$y_G = y_t - \tan \beta (x_g - x_t),$$

whence

$$x_g = \frac{y_t - y_G}{\tan \beta} + x_t$$

Yielding the co-ordinates of the initial point of the free yarn length. (Invariably the co-ordinate $z_t = 2t$ of the needle concerned is taken as value z.)

During pressing the break in the yarn path due to lapping will be displaced together with the needle stem, approximately applied to an extent corresponding to the height of the needle hook. Thus, x_B from the x_B, y_B values settled for the previous phase, has to be replaced by $x_B + \dfrac{v}{\sin\beta}$ for the time of pressing, while y_B remains unchanged until the breaking point of the yarn path is at the top of the needle hook. Beginning from the position

$$y_B = y_t$$

the breaking point assumes the co-ordinate of the needle top because the sinking needle carries the yarn with.

At that moment also the momentary value x of the breaking point in the path of the yarn lapped is that of the needle top.

On the basis of the above, in the third phase of the loop formation process, the yarn length is given by the following relationship:

$$d_{III} = \left[\left(x_B + \frac{v}{\sin\beta} - x_G\right)^2 + (y_B - y_G)^2 + (z_B - z_t)^2\right]^{\frac{1}{2}} + $$
$$+ \left[\left(x_l - x_B - \frac{v}{\sin\beta}\right)^2 + (y_l - y_B)^2 + (z_l - z_B)^2\right]^{\frac{1}{2}} +$$
$$[(x_i - x_l)^2 + (y_i - y_l)^2 + (z_i - z_l)^2]^{\frac{1}{2}} \tag{2}$$

provided pressing is applied, i.e. if the unequality

$$x_{pr} - \left[\frac{y_t - y_{pr}}{\tan\beta} + x_t - \frac{v}{\sin\beta}\right] \geq 0$$

expressed from (1) hold, else the term $\dfrac{v}{\sin\beta}$ in (2) is served. Beginning with $y_B = y_t$, x_B and y_B in (2) are replaced by x_t and y_t, respectively.

Fourth phase of the loop formation process (loop shaping)

At an appropriate yarn tension knocking-over takes place — approximately — when the point of the sinker profile contacting the fabric attains the height of the needle tip ($y_G = y_t$). (Actually, the old loops lay somewhat behind the yarn section lying on the sinker profile, therefore knocking over is slightly delayed. In our calculation this delay is neglected.)

The needle continuing its sinking movement carries a yarn loop of $2f$ length along (Fig. 10) for the formation of the new loop.

If the draw-off mechanism is set for delivering a fabric length equal to the loop size, no more yarn is demanded at the beginning of the new loop formation cycle, i.e. with the needle rising, and no excess yarn drawn off will slip back towards the guide. This was the position assumed in relationship and approximations used for the first phase of the loop formation process. (Provided the relation between fabric draw-off and yarn tension resulting a different loop size, this has to be taken into consideration in the calculation.)

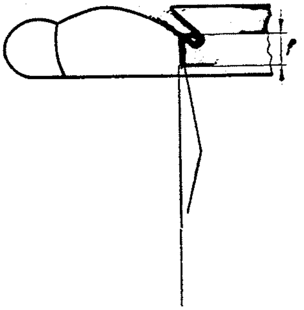

Fig. 10.

In the case given, the yarn passes from the starting point determined by the sinker to above the tip of the adjacent needle (surrounded by the yarn), from there it goes to the needle tip and back its path corresponding to about the loop length $2f$, then it continues its path to the guide and finally to the tension bar. (The yarn loop assumed drawn-off by the needle is to be fully compressed by the loop knocked-over, the limbs of the loop pointing to direction y)

$$f = y_G - y_t$$

and the yarn demand in the fourth phase of the loop formation process:

$$d_{IV} = t + 2f + [(x_l - x_t)^2 + (y_l - y_p)^2 + (z_l - z_B)^2]^{\frac{1}{2}} + \\ + [(x_i - x_l)^2 + (y_i - y_l)^2 + (z_i - z_l)^2]^{\frac{1}{2}} .$$

(The sinker profile height corresponding to x_t does not fully agree with the value y_p of the throat point, but the slight change in the profile (substituted by the sine curve) near to the throat point in direction y can be neglected. Hence, the two co-ordinates y are considered as identical in our calculation.)

Thereupon a computer flow chart can be prepared (Fig. 11). In addition to the check referred to on page 79 also a further check is included in the program. This is made possible by the fact that since both guide bars producing the fabric structure perform identical lapping movements of one needle spacing, yarns of the first guide bar are the first to contact the needle (breaking point in the yarn path). Provided an error in data recording or calculation inverts the succession order, the inconsistency is printed.

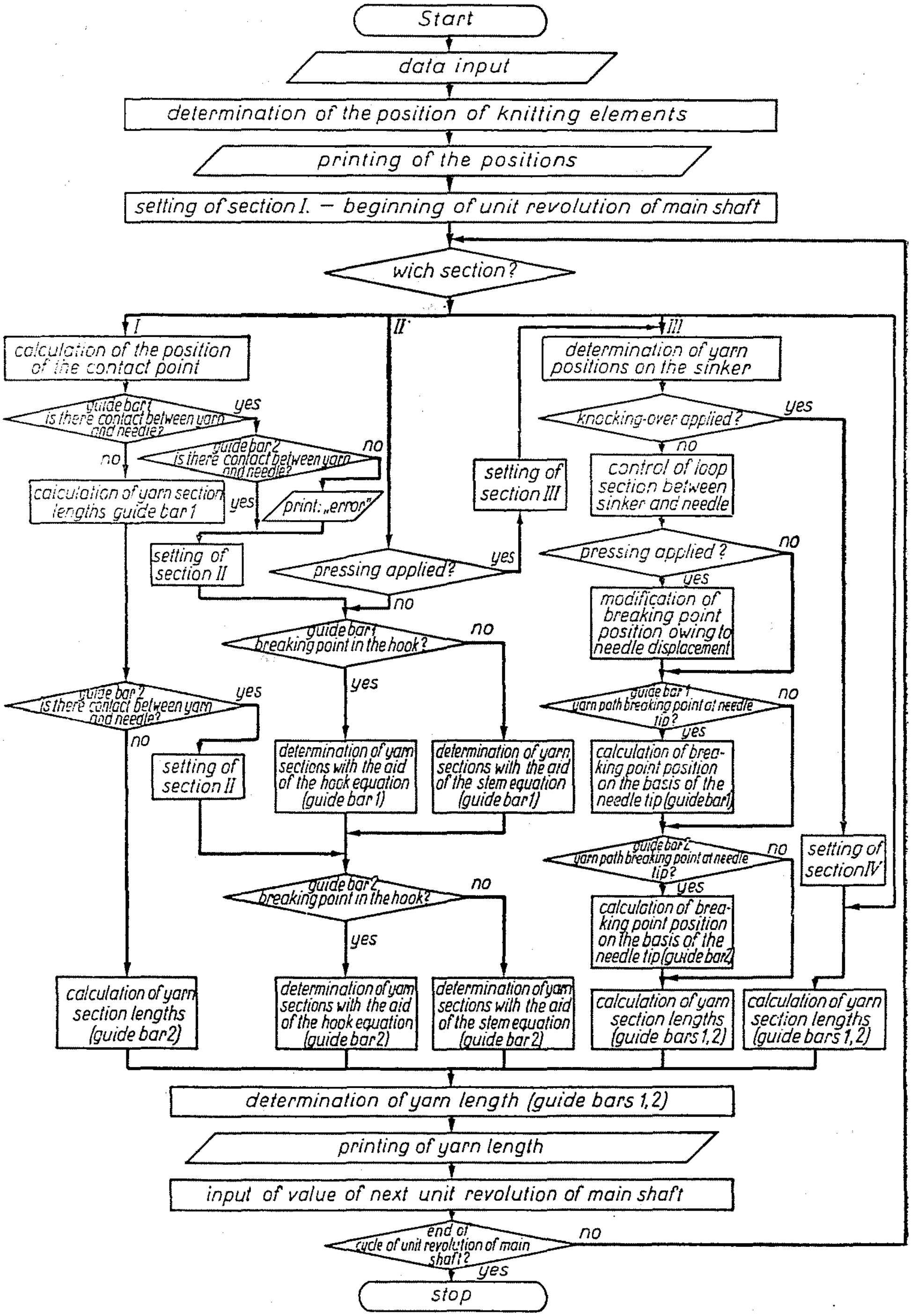
Start
data input
determination of the position of knitting elements
printing of the positions
setting of section I. — beginning of unit revolution of main shaft
wich section?
I
II
III
calculation of the position of the contact point
guide bar 1 is there contact between yarn and needle?
yes
no
guide bar 2 is there contact between yarn and needle?
no
calculation of yarn section lengths guide bar 1
yes
print: „error"
setting of section II
pressing applied?
yes
no
setting of section III
determination of yarn positions on the sinker
knocking-over applied?
yes
no
control of loop section between sinker and needle
pressing applied?
no
yes
modification of breaking point position owing to needle displacement
guide bar 1 breaking point in the hook?
no
yes
guide bar 2 is there contact between yarn and needle?
yes
no
setting of section II
determination of yarn sections with the aid of the hook equation (guide bar 1)
determination of yarn sections with the aid of the stem equation (guide bar 1)
guide bar 1 yarn path breaking point at needle tip?
no
yes
calculation of breaking point position on the basis of the needle tip (guide bar 1)
guide bar 2 yarn path breaking point at needle tip?
no
yes
setting of section IV
calculation of breaking point position on the basis of the needle tip (guide bar 2)
guide bar 2 breaking point in the hook?
no
yes
calculation of yarn section lengths (guide bar 2)
determination of yarn sections with the aid of the hook equation (guide bar 2)
determination of yarn sections with the aid of the stem equation (guide bar 2)
calculation of yarn section lengths (guide bars 1,2)
calculation of yarn section lengths (guide bars 1,2)
determination of yarn length (guide bars 1,2)
printing of yarn length
input of value of next unit revolution of main shaft
end of cycle of unit revolution of main shaft?
no
yes
stop

Fig. 11.

The program prepared on the basis of the flow chart can be used without any modification in examining stationary or rotating tension bars. For a rotating tension bar, the data-tape has to contain a block of the positions of the tension bar, while for stationary tension bar, a block containing the identical terms of the position of the stationary tension bar is required.

Flow chart Fig. 11 is seen to follow as sections I to IV the four distinct phases of the loop formation process. As yarn demand is determined for both guide bars for any angle of revolution of the main shaft, computer determination for one knitting cycle requires a single run.

Summary

The yarn demand of loop formation on warp knitting machines is calculated by a method likely to determine the yarn path (between the tension bar and the last loop formed) belonging to any small rotation angle of the main shaft of the knitting machine if the movement and relative initial positions of the knitting elements and those of the tension bars are known.

Knowledge of the variation in yarn demand permits to compare fabric and machine constructions to choosen the most favourable machine setting.

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