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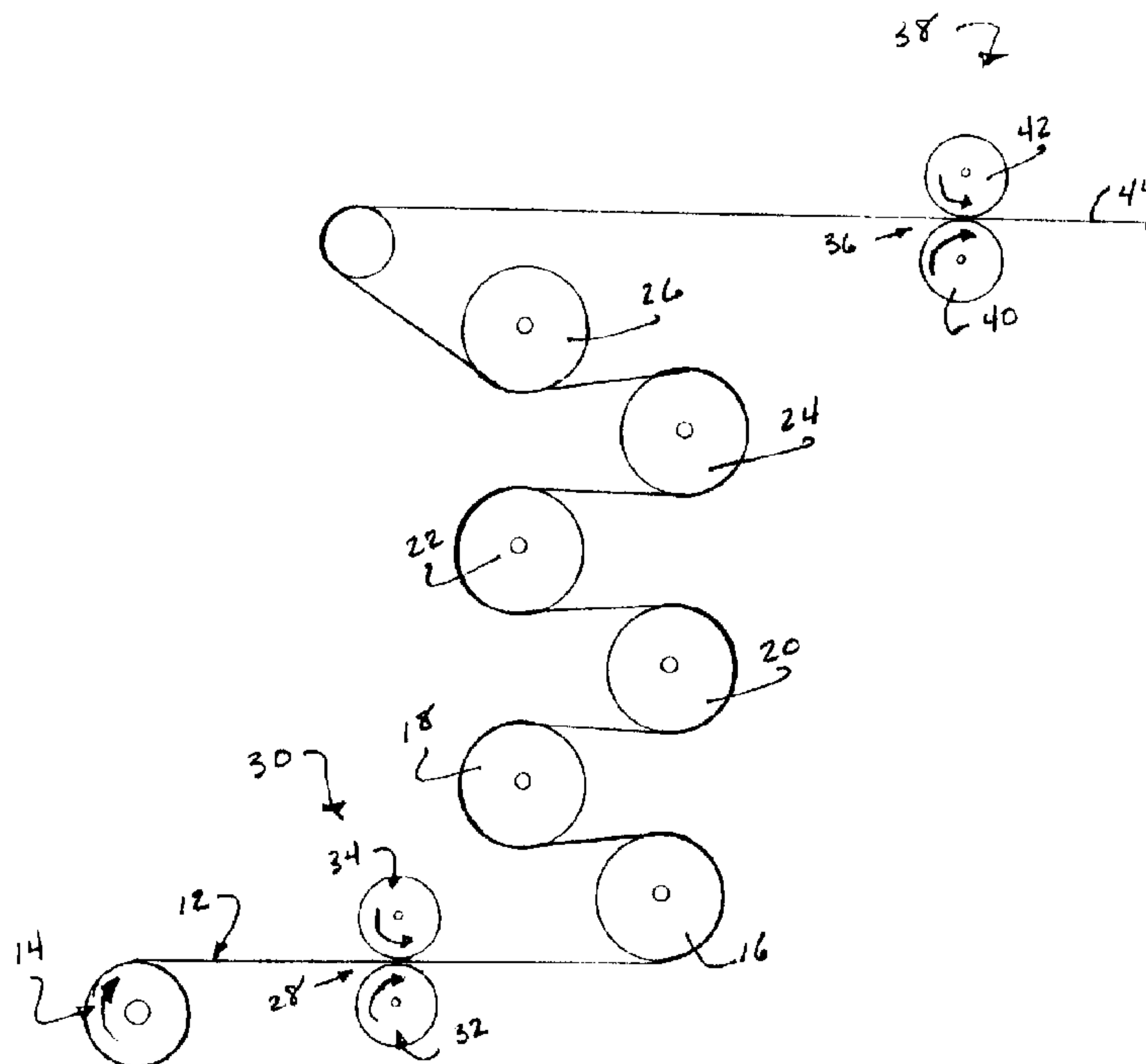
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(54) Titre : NON-TISSE COTELE RESSEMBLANT A UNE ETOFFE ET PROCEDE POUR SA FABRICATION

(54) Title: RIBBED CLOTHLIKE NONWOVEN FABRIC AND PROCESS FOR MAKING SAME



(57) Abrégé/Abstract:

There is provided herein a method of producing a ribbed clothlike nonwoven fabric comprising the steps of providing a nonwoven web of thermoplastic polymer of staple length or longer fibers or filaments having a pattern of fused bond areas wherein the pattern has at least one space and at least one unit width, as defined herein, in a ratio of at least 0.30, and then extending the web up to less than the breaking point of the fibers or filaments in at least one direction. The product which is thereby produced is a ribbed clothlike nonwoven fabric comprising a web of thermoplastic polymer of staple length or longer fibers or filaments having a pattern of fused bond areas wherein the pattern has space and unit width in a ratio of at least 0.30, and wherein the fabric has been extended up to less than the breaking point of the fibers or filaments in at least one direction so as to produce ribs. The stretching may be accompanied by heating by methods known in the art to a temperature ranging from greater than the polymer's alpha-transition temperature to about 10 percent below the onset of melting at a liquid fraction of 5 percent.

ABSTRACT

There is provided herein a method of producing a ribbed clothlike nonwoven fabric comprising the steps of providing a nonwoven web of thermoplastic polymer of staple
5 length or longer fibers or filaments having a pattern of fused bond areas wherein the pattern has at least one space and at least one unit width, as defined herein, in a ratio of at least 0.30, and then extending the web up to less than the breaking point of the fibers or filaments in at
10 least one direction. The product which is thereby produced is a ribbed clothlike nonwoven fabric comprising a web of thermoplastic polymer of staple length or longer fibers or filaments having a pattern of fused bond areas wherein the pattern has space and unit width in a ratio of at least
15 0.30, and wherein the fabric has been extended up to less than the breaking point of the fibers or filaments in at least one direction so as to produce ribs.

The stretching may be accompanied by heating by methods known in the art to a temperature ranging from
20 greater than the polymer's alpha-transition temperature to about 10 percent below the onset of melting at a liquid fraction of 5 percent.

PATENT

RIBBED CLOTHLIKE NONWOVEN FABRIC AND PROCESS FOR MAKING SAMEBACKGROUND OF THE INVENTION

5 This invention relates to the field of nonwoven fabrics for durable or non-durable use.

Nonwoven fabrics have been produced by a number of processes for a number of decades. Their uses have been many, for example as components of diapers, disposable
10 wipes, feminine hygiene products, surgical gowns and drapes, industrial wipes, oil spill cleanup materials and even applications in the furniture and apparel markets.

A disadvantage that nonwoven fabrics have had in applications as apparel has been that nonwoven fabrics have
15 not exhibited a clothlike feel, stretch or visual aesthetic similar to woven or knitted fabrics. Nonwoven fabrics have generally been point bonded in such a way as to be relatively flat and visually unattractive and to have a relatively rough hand when compared to more expensive
20 textiles.

A number of treatments have been developed to soften nonwoven fabrics such as multiple washings, chemical treatments, or stretching. While these techniques have been successful in softening nonwoven fabrics somewhat,
25 none has proven completely satisfactory for the apparel market.

SUMMARY

This invention provides a nonwoven fabric with a
30 clothlike feel, stretch and visual appeal.

There is also provided a method of producing a ribbed clothlike nonwoven fabric comprising the steps of providing a nonwoven web of thermoplastic polymer fibers or filaments having a pattern of fused bond areas, said pattern
35 providing columns of unbonded area extending along the fabric, and wherein the pattern has space and unit width, as defined herein, in a ratio of at least 0.30, and then extending the web up to less than the breaking point of the

fibers or filaments in at least one direction. The product which is thereby produced is a ribbed clothlike nonwoven fabric comprising a web of thermoplastic polymer of staple length or longer fibers or filaments having a pattern of fused bond areas wherein the pattern has space and unit width in a ratio of at least 0.30, and wherein the fabric has been extended up to less than the breaking point of the fibers or filaments in at least one direction so as to produce ribs.

The stretching may be accompanied by heating methods known in the art to a temperature ranging from greater than the polymer's alpha-transition temperature to about 10 percent below the onset of melting at a liquid fraction of 5 percent.

In one embodiment, the method further comprises a step of allowing said web to relax under low or no tension after extending.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an illustration of a process of treating a nonwoven fabric.

Figure 2 is a photograph at a magnification of 7.2X, of a nonwoven fabric which has been bonded with a pattern which is in accordance with the invention.

Figure 3 is a photograph at a magnification of 7.2X, of the nonwoven fabric of Figure 2 after stretching.

Figure 4 is a photograph of a typical knit sweater at a magnification of 3.6X.

Figure 5 is a photograph at a magnification of 7.2X, of a nonwoven fabric which has been bonded with a pattern which is not in accordance with the invention.

Figure 6 is a photograph at a magnification of 7.2X, of the nonwoven fabric of Figure 5 after stretching.

Figure 7 is a photograph at a magnification of 7.2X, of a nonwoven fabric which has been bonded with a pattern which is in accordance with the invention.

Figure 8 is a photograph at a magnification of 7.2X, of the nonwoven fabric of Figure 7 after stretching.

Figure 9 is a photograph at a magnification of 7.2X, of a typical knit sweater.

Figures 10 and 11 are illustrations of bonding patterns which are not in accordance with the invention.

5 Figures 12 through 17 are illustrations of bonding patterns which are in accordance with the invention.

DEFINITIONS

10 As used herein the term "nonwoven fabric or web" means a web having a structure of individual fibers, filaments or threads which are interlaid, but not in an identifiable manner. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes,
15 spunbonding processes, and bonded carded web processes.

 As used herein the term "microfibers" means small diameter fibers having an average diameter not greater than about 100 microns, for example, having an average diameter of from about 0.5 microns to about 50 microns, or more
20 particularly, microfibers may desirably have an average diameter of from about 2 microns to about 40 microns.

 As used herein the term "meltblown fibers" means fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die
25 capillaries as molten threads or filaments into a high velocity, usually heated gas (e.g. air) stream which attenuates the filaments of molten thermoplastic material to reduce their diameter, which may be to microfiber diameter. Thereafter, the meltblown fibers are carried by
30 the high velocity gas stream and are deposited on a collecting surface to form a web of randomly disbursed meltblown fibers. Such a process is disclosed, for example, in U.S. Patent no. 3,849,241 to Butin.

 As used herein the term "spunbonded fibers" refers to
35 small diameter fibers which are formed by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a spinnerette with

the diameter of the extruded filaments then being rapidly reduced as by, for example, in U.S. Patent no. 4,340,563 to Appel et al., and U.S. Patent no. 3,692,618 to Dorschner et al.

5 As used herein the term "machine direction" refers to the direction of formation of the meltblown or spunbond web. Since such webs are generally extruded onto a moving conveyor belt or "forming wire", the direction of formation of such webs (the machine direction) is the direction of
10 movement of the forming wire. The terms "cross direction" and "cross machine direction" mean a direction which is substantially perpendicular to the machine direction.

 As used herein the term "bicomponent" refers to fibers which have been formed from at least two polymers extruded
15 from separate extruders but spun together to form one fiber. The configuration of such a bicomponent fiber may be, for example, a sheath/core arrangement wherein one polymer is surrounded by another or may be a side by side arrangement.

20 As used herein the term "polymer" generally includes but is not limited to, homopolymers, copolymers, such as for example, block, graft, random and alternating copolymers, terpolymers, etc. and blends and modifications thereof. Furthermore, unless otherwise specifically
25 limited, the term "polymer" shall include all possible geometrical configuration of the material. These configurations include, but are not limited to isotactic, syndiotactic and random symmetries.

 As used herein the term "recover" refers to a
30 contraction of a stretched material upon termination of a biasing force following stretching of the material by application of the biasing force. For example, if a material having a relaxed, unbiased length of one (1) inch was elongated 50 percent by stretching to a length of one
35 and one half (1.5) inches the material would have been elongated 50 percent and would have a stretched length that is 150 percent of its relaxed length. If this exemplary

stretched material contracted, that is recovered to a length of one and one tenth (1.1) inches after release of the biasing and stretching force, the material would have recovered 80 percent (0.4 inch) of its elongation.

5 As used herein, the terms "necking" or "neck stretching" interchangeably refer to a method of elongating a nonwoven fabric, generally in the machine direction, to reduce its width in a controlled manner to a desired amount. The controlled stretching may take place under
10 cool, room temperature or greater temperatures and is limited to an increase in overall dimension in the direction being stretched up to the elongation required to break the fabric, which in most cases is about 1.2 to 1.4 times. Such processes are disclosed, for example, in U.S.
15 Patent no. 4,443,513 to Meitner and Notheis, U.S. Patent no. 4,965,122 to Morman and Canadian patent application no. 2,096,985, filed May 26, 1993.

As used herein the term "unit width" refers to the distance from the beginning of a column of bond points to
20 the beginning of the next nearest column of bond points as measured in the cross machine direction. Such a measurement will necessarily include the width of one discrete column of bond points and the width of the unbonded distance between the included column of bond
25 points and the next column of bond points. The term "space" refers to the width of the unbonded area between the two neighboring columns of bond points.

As used herein, the term "rib" means a raised ridge, cord or wale in a fabric. An example of ribbing is the
30 parallel ridges in the surface of a fabric such as corduroy.

As used herein, the term "garment" means any type of apparel which may be worn. This includes diapers, training pants, incontinence products, surgical gowns, industrial
35 workwear and coveralls, undergarments, pants, shirts, jackets and the like.

DETAILED DESCRIPTION OF THE INVENTION

5 The field of nonwoven fabrics is a diverse one encompassing absorbent products such as diapers, wipes and feminine hygiene products and barrier products such as surgical gowns and drapes, car covers, and bandages. Nonwovens are also used for more durable applications such as apparel, though the visual aesthetics, stretch and the
10 feel of nonwovens has limited the acceptance of nonwovens in this area.

A product and a process for producing the product have been developed which yield a stretchable clothlike ribbed nonwoven fabric which is quite similar to woven or knit
15 materials.

The fibers from which the fabric of this invention is made may be produced by the meltblowing or spunbonding processes which are well known in the art. These processes generally use an extruder to supply melted thermoplastic polymer to a spinnerette where the polymer is fiberized and
20 yield fibers which may be staple length or longer. The fibers are then drawn, usually pneumatically, and deposited on a foraminous mat or belt to form the nonwoven fabric. The fibers produced in the spunbond and meltblown processes
25 are microfibers as defined above.

The fabric used in the process of this invention may be a single layer embodiment or a multilayer laminate. Such a multilayer laminate may be an embodiment wherein some of the layers are spunbond and some meltblown such as
30 a spunbond/meltblown/spunbond (SMS) laminate as disclosed in U.S. Patent no. 4,041,203 to Brock et al. and U.S. Patent no. 5,169,706 to Collier, et al. Such a laminate may be made by sequentially depositing onto a moving forming belt first a spunbond fabric layer, then a
35 meltblown fabric layer and last another spunbond layer and then bonding the laminate in a manner described below. Alternatively, the fabric layers may be made individually,

collected in rolls, and combined in a separate bonding step. Such fabrics usually have a basis weight of from about 6 to about 400 grams per square meter. The process of this invention may also produce fabric which has been
5 laminated with films, glass fibers, staple fibers, paper, and other web materials.

Nonwoven fabrics are generally bonded in some manner as they are produced in order to give them sufficient structural integrity to withstand the rigors of further
10 processing into a finished product. Bonding can be accomplished in a number of ways such as hydroentanglement, needling, ultrasonic bonding, adhesive bonding and thermal bonding. Thermal bonding is the method preferred in this invention.

15 Thermal bonding of a nonwoven may be accomplished by passing the nonwoven fabric between the rolls of a calendering machine. At least one of the rollers of the calender is heated and at least one of the rollers, not necessarily the same one as the heated one, has a pattern
20 which is imprinted upon the nonwoven fabric as it passes between the rollers. As the fabric passes between the rollers it is subjected to pressure as well as heat. The combination of heat and pressure applied in a particular pattern results in the creation of fused bond areas in the
25 nonwoven fabric where the bonds on the fabric correspond to the pattern of bond points on the calender roll.

The exact calender temperature and pressure for bonding the nonwoven web depend on thermoplastic(s) from which the web is made. Generally for polyolefins the
30 preferred temperatures are between 150 and 350°F (66 and 177°C) and the pressure between 300 and 1000 pounds per lineal inch. More particularly, for polypropylene, the preferred temperatures are between 270 and 320°F (132 and 160°C) and the pressure between 400 and 800 pounds per
35 lineal inch.

The thermoplastic polymers which may be used in the practice of this invention may be any known to those

skilled in the art to be commonly used in meltblowing and spunbonding. Such polymers include polyolefins, polyesters and polyamides, and mixtures thereof, more particularly polyolefins such as polyethylene, polypropylene, polybutene, ethylene copolymers, propylene copolymers and butene copolymers.

Various patterns for calender rolls have been developed. One example is the expanded Hansen Pennings pattern with about a 15% bond area with about 100 bonds/square inch as taught in U.S. Patent 3,855,046 to Hansen and Pennings. Another common pattern is a diamond pattern with repeating and slightly offset diamonds.

It has been found to be critical for the formation of ribs in a nonwoven fabric, that the pattern of bonding have columns of unbonded area extending along the fabric. In a pattern of this type the bonded areas line up fairly regularly under each other through a given length of fabric and the unbonded areas do as well.

It is not necessary, however, that the bond areas line up exactly under each other through the given length of fabric, i.e. the columns need not be exactly perpendicular to the direction of stretch, just that they provide a column of open, unbonded area. Indeed, many patterns which meet the requirements of this invention are skewed at an angle of up to 5 degrees to the direction of production (the machine direction) of the nonwoven web. Such a slightly skewed though substantially perpendicular pattern is intended to be encompassed within the boundaries of this invention.

One method of defining the type of pattern necessary in the practice of this invention is to calculate the ratio of the width of open space between columns of bond points, to the distance from the beginning of one column of bond points to another (the "unit width" as defined above) in nonwoven fabrics having a columnar pattern. It has been found that the ratio of space to unit width must be at least 0.3 to practice this invention and that fabrics

meeting this criterion will form ribs in the unbonded area upon stretching. Examples of such bond patterns may be found in Figures 12-17 where "S" refers to the width of open space between columns of bond points, and "W" refers to the distance from the beginning of one column of bond points to another (the "unit width"). It should also be noted that many patterns have more than one space and/or unit width (e.g. Figure 16), therefore, the ratio of at least one space to at least one unit width must be at least 0.3 to practice this invention.

The diamond pattern as mentioned above provides rows of diamonds which do not line up one above the other in the machine direction. As a result the unbonded area does not form a column and such diamond bonded nonwovens do not produce a ribbed clothlike nonwoven fabric upon stretching. Such a pattern is discussed in Comparative Example 1 below.

After the nonwoven has been bonded with a pattern, it is neck stretched. Neck stretching or necking is known in the art for the purpose of softening, stretching or increasing the bulk of a nonwoven fabric. Such processes are disclosed, for example, in U.S. Patent no. 4,443,513 to Meitner and Notheis and another in U.S. Patent no. 4,965,122 to Morman.

Necking can be performed as the fabric is being produced or can be done as a secondary operation some time after production of the bonded nonwoven fabric. In necking, the fabric is stretched in the machine direction to a point below the breaking point of the filaments or fibers which make up the fabric. More particularly, the fabric may be stretched to up to 140% of its original length. The stretching may be accompanied by heating or may be performed at room temperature or below.

One particularly acceptable method of stretching the nonwoven web is explained in detail in Canadian Patent Application Serial No. 2,096,985, which was filed on May 26, 1993.

In this method, the nonwoven web is heated to a temperature ranging from greater than the polymer's alpha-

transition temperature to about 10 percent below the onset of melting at a liquid fraction of 5 percent, prior to stretching. One way to roughly estimate a temperature approaching the upper limit of such heating is to multiply the polymer melt temperature (expressed in degrees Kelvin) by 0.95.

Alternatively, the nonwoven may be stretched at room temperature and then heated while stretched to "set" the stretch into the fabric (as in U.S. Patent no. 4,965,122).

Heating of a nonwoven web may be performed by passing the web over a series of steam cans or heating by using infra-red waves, microwaves, ultrasonic energy, flame, hot gases (e.g. in an oven), hot liquids and the like.

The bonded stretched nonwoven fabric may be wound into a roll for transportation to further processing or may be used directly.

Thermal bonding with a pattern as described above and subsequent necking produce a nonwoven fabric having ribs along the columns of unbonded areas. Ribs are an important factor in creating a clothlike feel and look to a fabric.

Following is an example of the production of a ribbed clothlike nonwoven web of this invention and a comparative example of a nonwoven web not possessing clothlike attributes to as desirable a degree.

EXAMPLE 1

A spunbond/meltblown/spunbond (SMS) thermoplastic web laminate was produced having a basis weight of 1.4 ounces per square yard (osy) in accordance with the procedures described in U.S. Patent no. 4,307,143 to Meitner et al. The laminate had a meltblown layer of 0.4 osy and spunbond layers of 0.5 osy each. This web was produced by extruding molten polypropylene from a plurality of fine, circular capillaries of a spinnerette (spunbonding) onto a forming wire to form a layer of small diameter fibers, depositing a layer of meltblown polypropylene microfibers thereon, and

finally depositing another layer of spunbond polypropylene fiber over the meltblown layer.

5 The polypropylene used in the spunbond layers was PD9355™ from the Exxon Chemical Company, Baytown, Texas and the meltblown layer was of PD 3495G™ also from Exxon. The web was pattern bonded under heat and pressure conditions of 295°F (146°C) and 430 pounds per square inch with 20 inch (51 cm) diameter rolls in a pattern as illustrated in Figure 2. This pattern had a bond area of about 11% with
10 about 200 bonds/square inch.

This web was then stretched using the method illustrated in Figure 1. As shown in Figure 1, the nonwoven material or web 12 was unwound from a supply roll 14 and traveled in the direction indicated by the arrows associated therewith as the supply roll 14 rotated in the
15 direction of the arrows associated therewith. The material 12 passed through the nip 28 of a roller arrangement 30 in a path as indicated by the rotation direction arrows associated with the stack rollers 32 and 34. From the roller arrangement 30, the material 12 passed over a series
20 of heated drums (e.g., steam cans) 16-26 in a series of reverse S-loops. The steam cans 16-26 were about 24 inches (61 cm) in diameter although other sized cans may be used. The contact or residence time of the material 12 on the steam cans 16-26 was sufficient to raise the temperature of
25 the material 12 to about 242°F (117°C). The heated neckable material 12 then passed through the nip 36 of a drive roller arrangement 38 formed by the drive rollers 40 and 42. Because the peripheral linear speed of the rollers of the roller arrangement 30 is controlled to be less than
30 the peripheral linear speed of the rollers of the drive roller arrangement 38, the heated neckable material 12 was tensioned so that it necked a desired amount and was maintained in such tensioned, necked condition while it was cooled. In this example the material 12 was drawn 19% in
35 the machine direction at a speed of 50 feet/min (15 m/min).

Figure 2 shows the web of this example before stretching and Figure 12 shows the space to unit width ratios of this pattern.

After stretching, the resultant bonded necked nonwoven web is shown in Figure 3 and has a clothlike visual appearance. Figure 4 is a photograph of a typical knit material. The clothlike visual appearance of Figure 3 can be seen by a comparison of Figure 3 with Figure 4 which shows that the necked nonwoven web has the clothlike ribbing which is characteristic of a knit material.

COMPARATIVE EXAMPLE 1

A nonwoven laminate SMS web was produced according to the procedure in example 1. The polymer used in the meltblown layer was the same as example 1. The polymer used in the spunbond layers was PF 301™, available from Himont Chemical Company.

The bonding pattern was a diamond pattern as pictured in Figure 5 prior to stretching. This pattern has about 15% bond area with about 200 bonds/square inch with a repeating pattern of bonded and unbonded area arranged in such a way as to provide columns of bonded area next to columns of unbonded area wherein the ratio of space to unit width is less than 0.3. This pattern is also shown in Figure 10.

The diamond bonded SMS web was stretched in the manner described in example 1. The resultant neck stretched diamond bonded SMS web is shown in Figure 6. As can be seen from the Figure 6, the web does not have the clothlike visual appearance of that of Example 1 as shown in Figure 3.

EXAMPLE 2

A spunbond/meltblown/spunbond (SMS) thermoplastic web laminate was produced and stretched according to the procedure of Example 1. The same polymers as in Example 1 were used, the only difference being that the meltblown

layer had a basis weight of 0.5 osy, producing a total laminate basis weight of 1.5 osy. The bonding pattern was that shown in Figure 14 and known as "wire weave". This pattern has a space to unit width ratio of about 0.45 or 45% with a bond area of about 15% and about 300 bonds/square inch.

The bonded, unstretched web is shown in Figure 7 and the stretched web in Figure 8. Figure 9 is a tightly woven knit sweater for comparison purposes. As can be seen, the stretched wire weave bonded fabric also produces the ribs characteristic of a knit.

It can thus be seen from the above examples that a ribbed clothlike nonwoven fabric can be produced by using a bonding pattern as described above and then neckstretching the fabric.

5 **CLAIMS**

1. A method of producing a ribbed clothlike nonwoven fabric comprising the steps of:

10 providing a nonwoven web of thermoplastic polymer, said pattern providing columns of unbonded area extending along the fabric, and fibers or filaments having a pattern of fused bond areas wherein said pattern has at least one space and at least one unit width in a ratio of at least 0.30;

15 extending said web up to less than the breaking point of the fibers or filaments in at least one direction.

2. The method of claim 1, wherein said fabric is extended to less than about 140% of its original length.

20 3. The method of claim 1 or 2, further comprising the step of allowing said web to relax under low or no tension after extending.

25 4. The method of claim 1, 2 or 3, wherein said pattern of fused bond areas is selected from the group consisting of the patterns of Figures 12 through 17.

30 5. The method of any one of claims 1 to 4, wherein said web is heated to a temperature ranging from greater than said polymer's alpha-transition temperature to about 10 percent below the onset of melting at a liquid fraction of 5 percent, prior to extending said web.

35 6. The method of claim 5, wherein said web is heated to a temperature ranging from about 66 to about 177°C.

40 7. The method of claim 5 or 6, wherein said web is heated by a method selected from the group consisting of infra-red radiation, steam can, microwave, ultrasonic, flame, hot gas and hot liquid heating.

5 8. The method of any one of claims 1 to 7 further
comprising the step of heating said web to a temperature
ranging from greater than said polymer's alpha-transition
temperature to about 10 percent below the onset of
melting at a liquid fraction of 5 percent, after
10 extending said web.

9. A ribbed clothlike nonwoven fabric comprising a web
of thermoplastic polymer fibers or filaments having a
columnar pattern of fused bonded areas with columns of
15 unbonded area which extend along the fabric;

wherein said bonded and unbonded areas line up
substantially regularly through a given length of fabric
in columns only;

said pattern has at least one space and at least one
20 unit width in a ratio of at least 0.30, and;

wherein said fabric has been extended up to less than
the breaking point of the fibers or filaments in the
machine direction, and allowed to relax under low or no
tension so as to produce ribs.

25 10. The fabric of claim 9, wherein said web has been
heated to a temperature ranging from greater than said
polymer's alpha-transition temperature to about 10
percent below the onset of melting at a liquid fraction
30 of 5 percent, prior to extending said web.

11. The fabric of claim 9 or 10, wherein said web has
been heated to a temperature ranging from about 66 to
about 177°C.

35 12. The fabric of claim 9, 10 or 11, wherein said web
has been heated by a method selected from the group
consisting of infra-red radiation, steam can, microwave,
ultrasonic, flame, hot gas and hot liquid heating.

40 13. The fabric of any one of claims 9 to 12, which is

5 present in items selected from the group consisting of garments, disposable wipes, feminine hygiene products, surgical drapes, industrial wipes, furniture and oil spill cleanup materials.

10 14. The fabric of any one of claims 9 to 13, wherein said thermoplastic polymer is selected from the group consisting of polyolefins, polyamides and polyesters.

15 15. The fabric of any one of claims 9 to 13, wherein said thermoplastic polymer is selected from the group consisting of one or more of polyethylene, polypropylene, polybutene, ethylene copolymers, propylene copolymers and butene copolymers.

20 16. The fabric of any one of claims 9 to 15, wherein said nonwoven fabric has a basis weight of from about 6 to about 400 grams per square meter.

25 17. A multilayer material comprising at least one layer of the nonwoven fabric according to any one of claims 9 to 16, and at least one other layer.

30 18. A ribbed clothlike nonwoven fabric comprising a web of thermoplastic polymer fibers or filaments having a columnar pattern of fused bonded areas with columns of unbonded area which extend along the fabric;

wherein said bonded and unbonded areas line up substantially regularly through a given length of fabric; said pattern has at least one space and at least one unit width in a ratio of at least 0.30, and is selected from the group consisting of the patterns of FIGS. 12 through 17 and;

40 wherein said fabric has been extended up to less than the breaking point of the fibers or filaments in at least one direction so as to produce ribs.

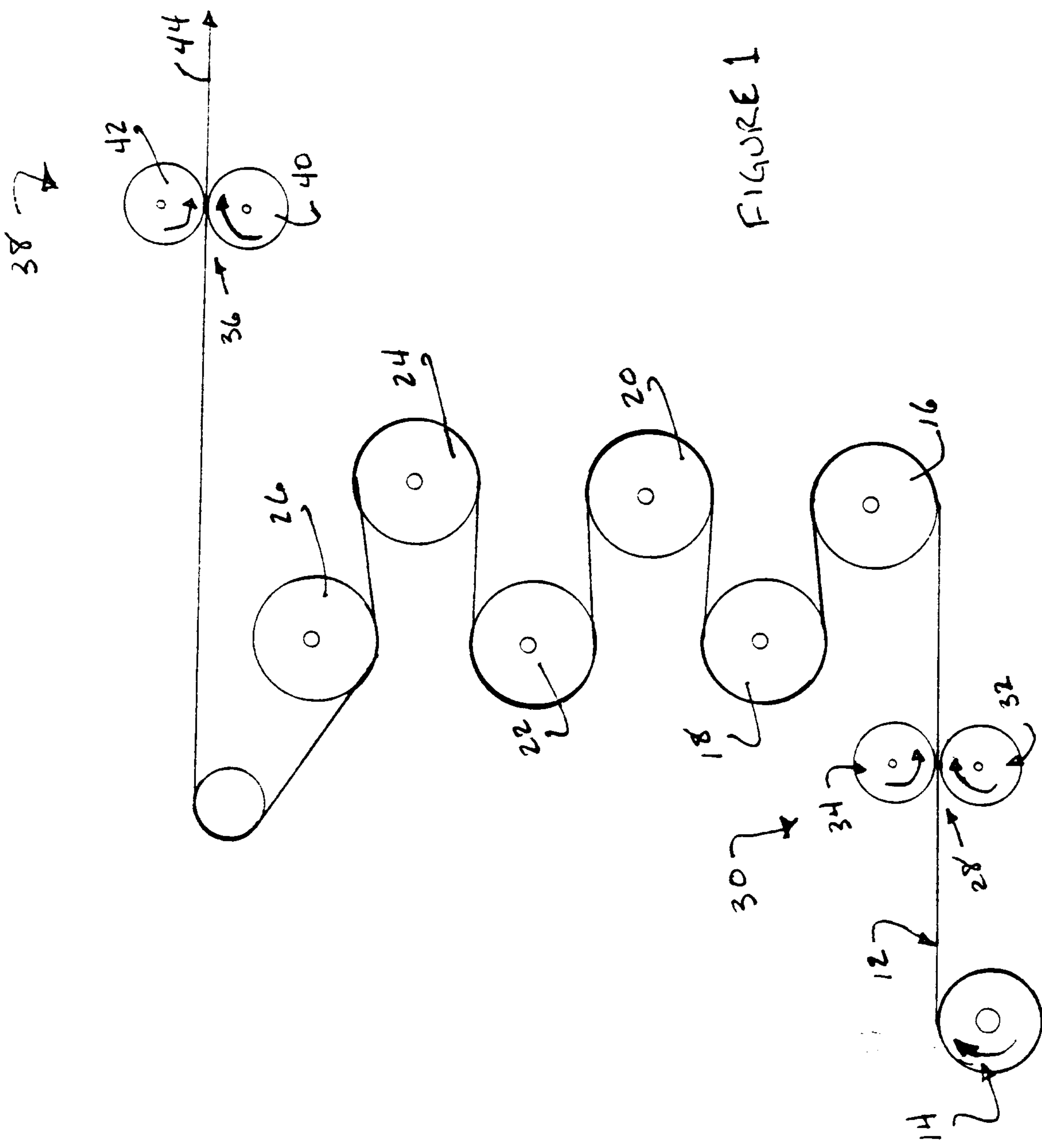


FIGURE 1

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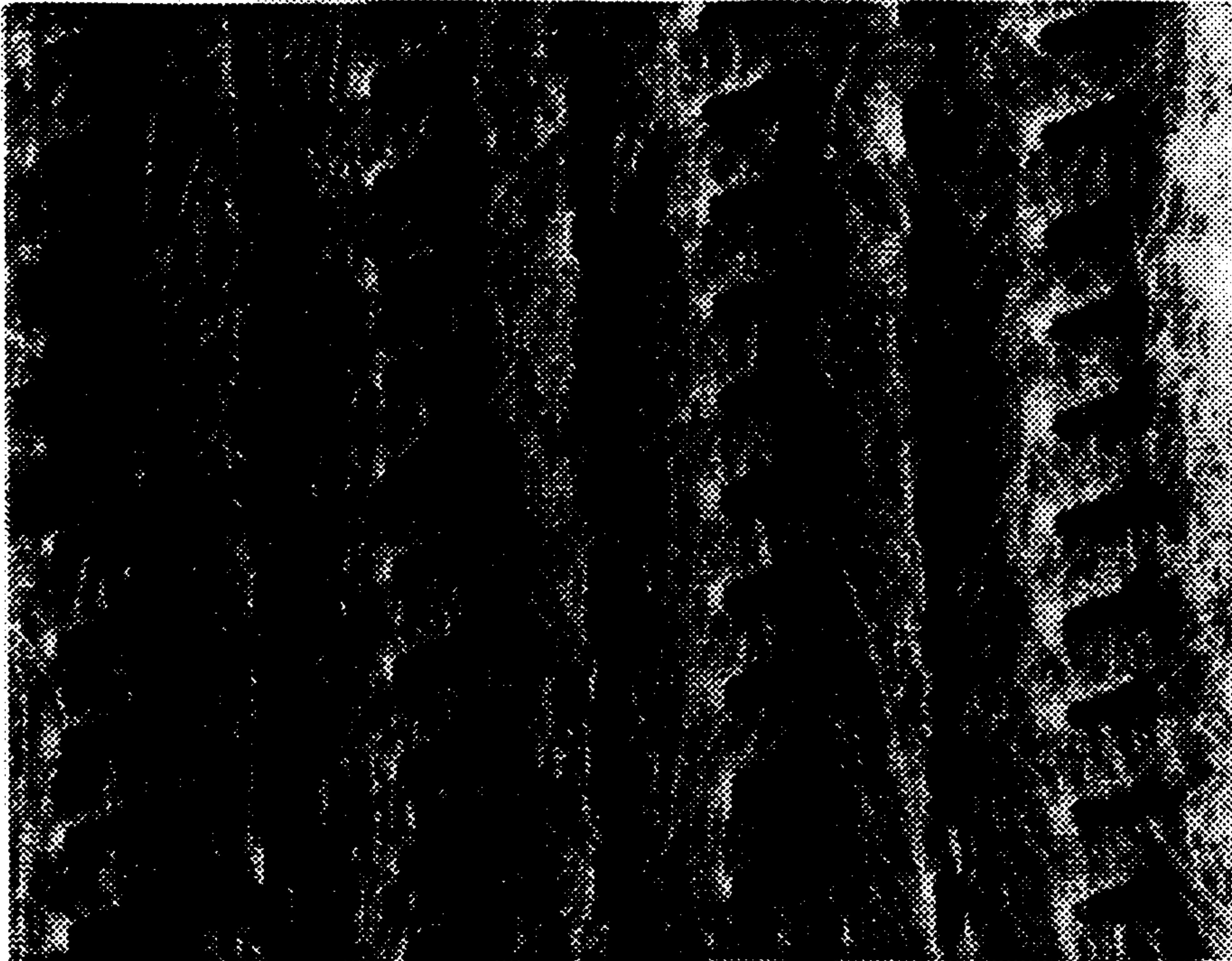


Figure 2

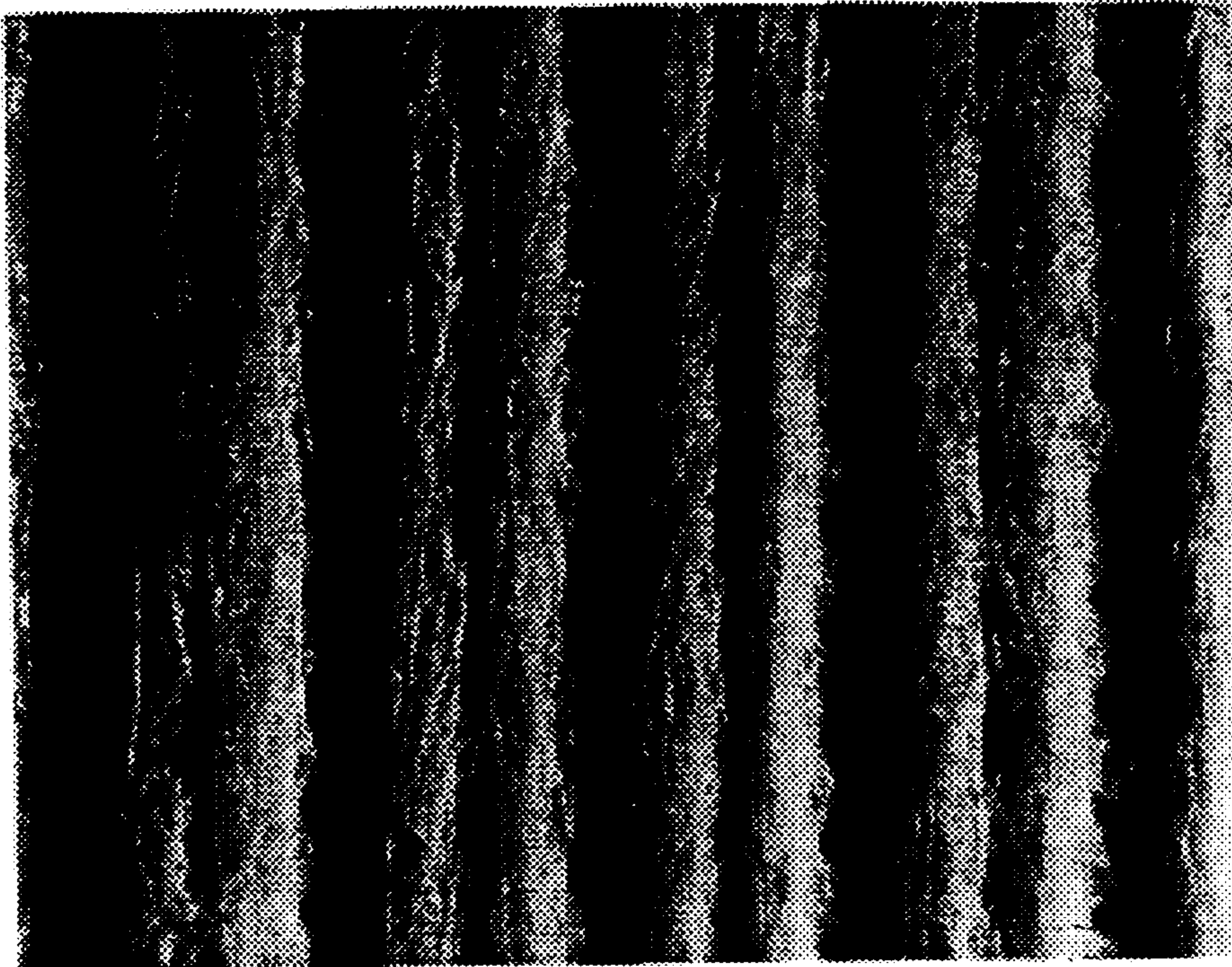


Figure 3

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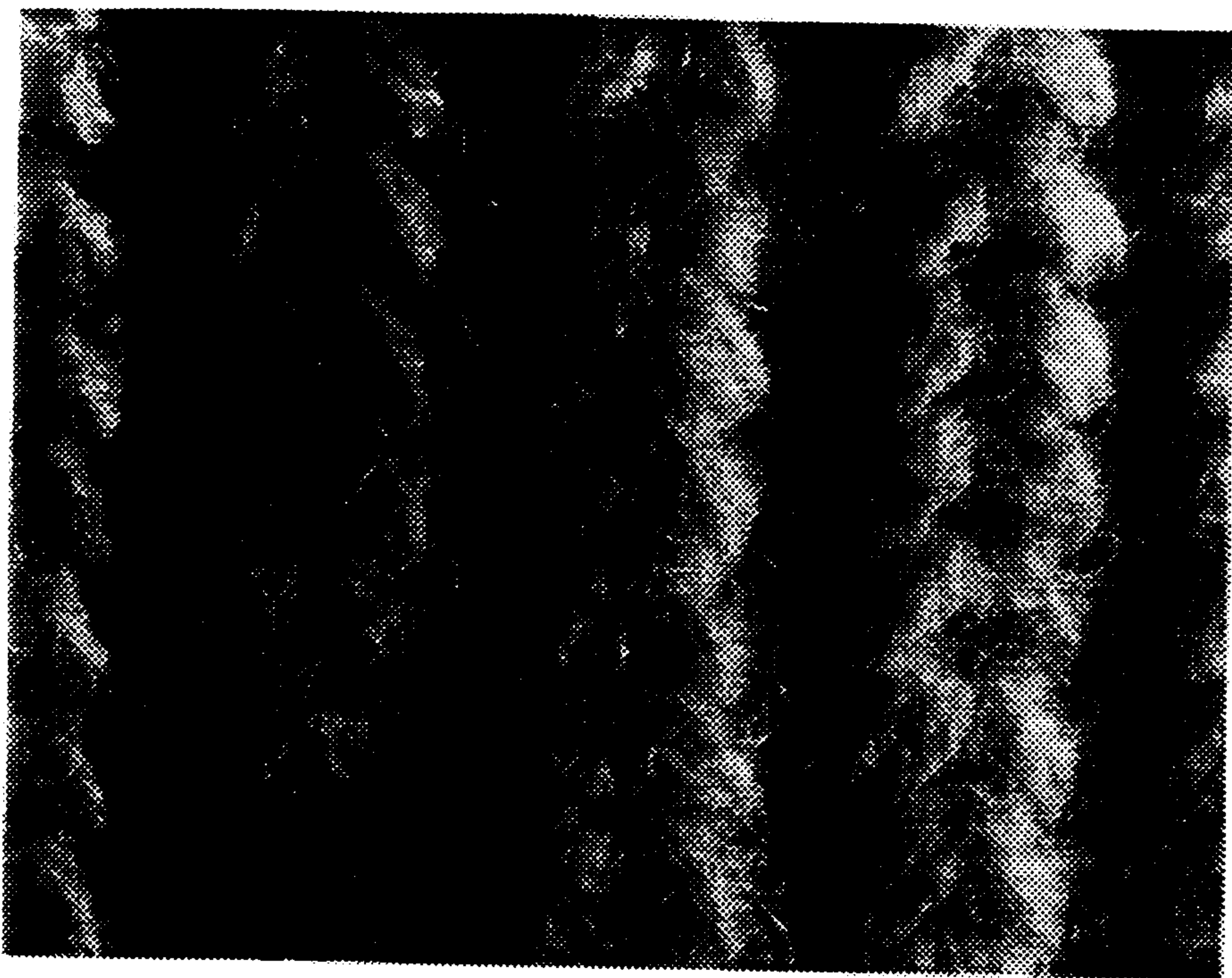


Figure 4

Application number / numéro de demande: 2123330

Figures: fig. 5 et 6

Pages: _____

Unscannable items
received with this application
(Request original documents in File Prep. Section on the 10th floor)

Documents reçu avec cette demande ne pouvant être balayés
(Commander les documents originaux dans la section de préparation des dossiers au
10^{ème} étage)



Figure 7

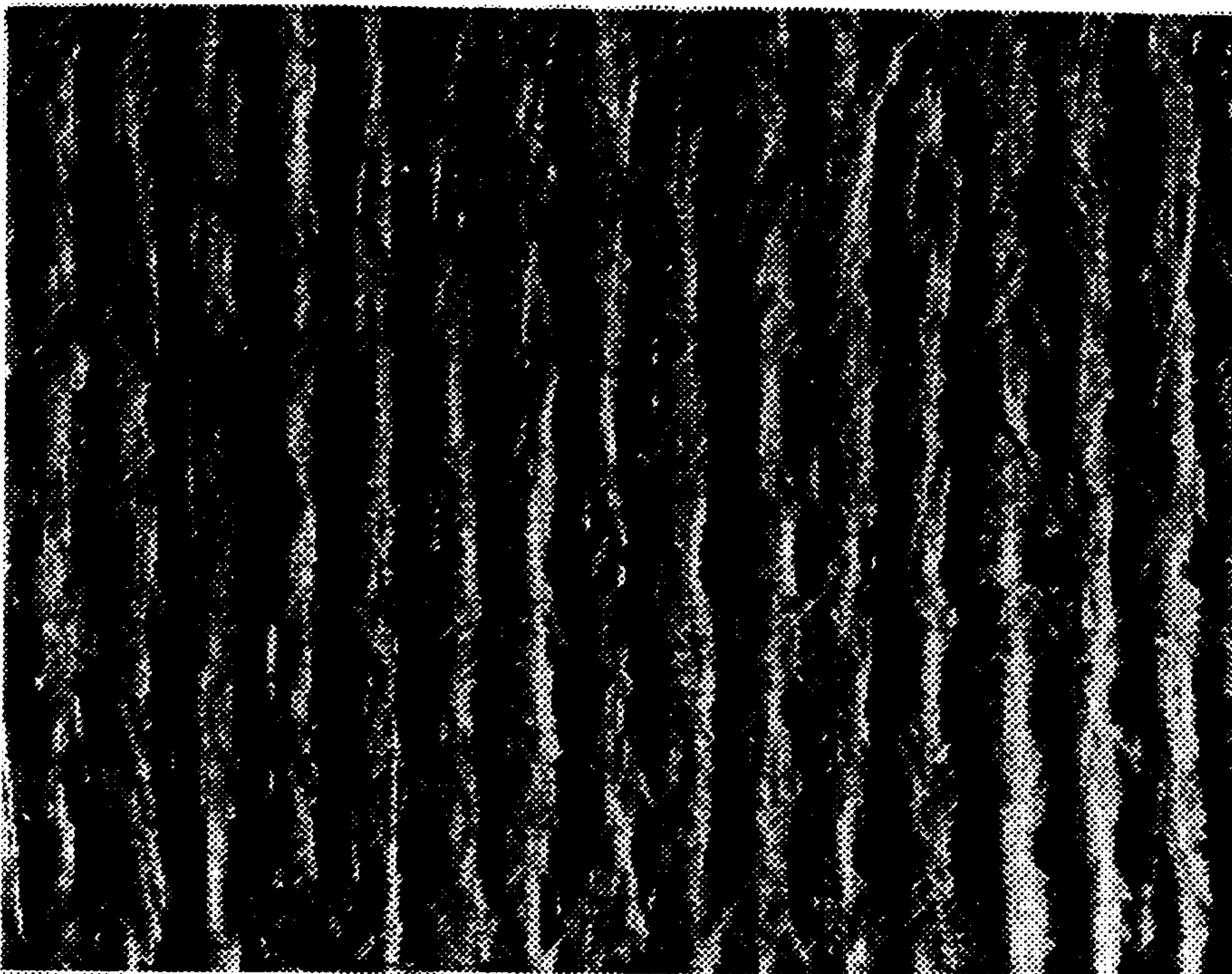


Figure 8

2123330



Figure 9

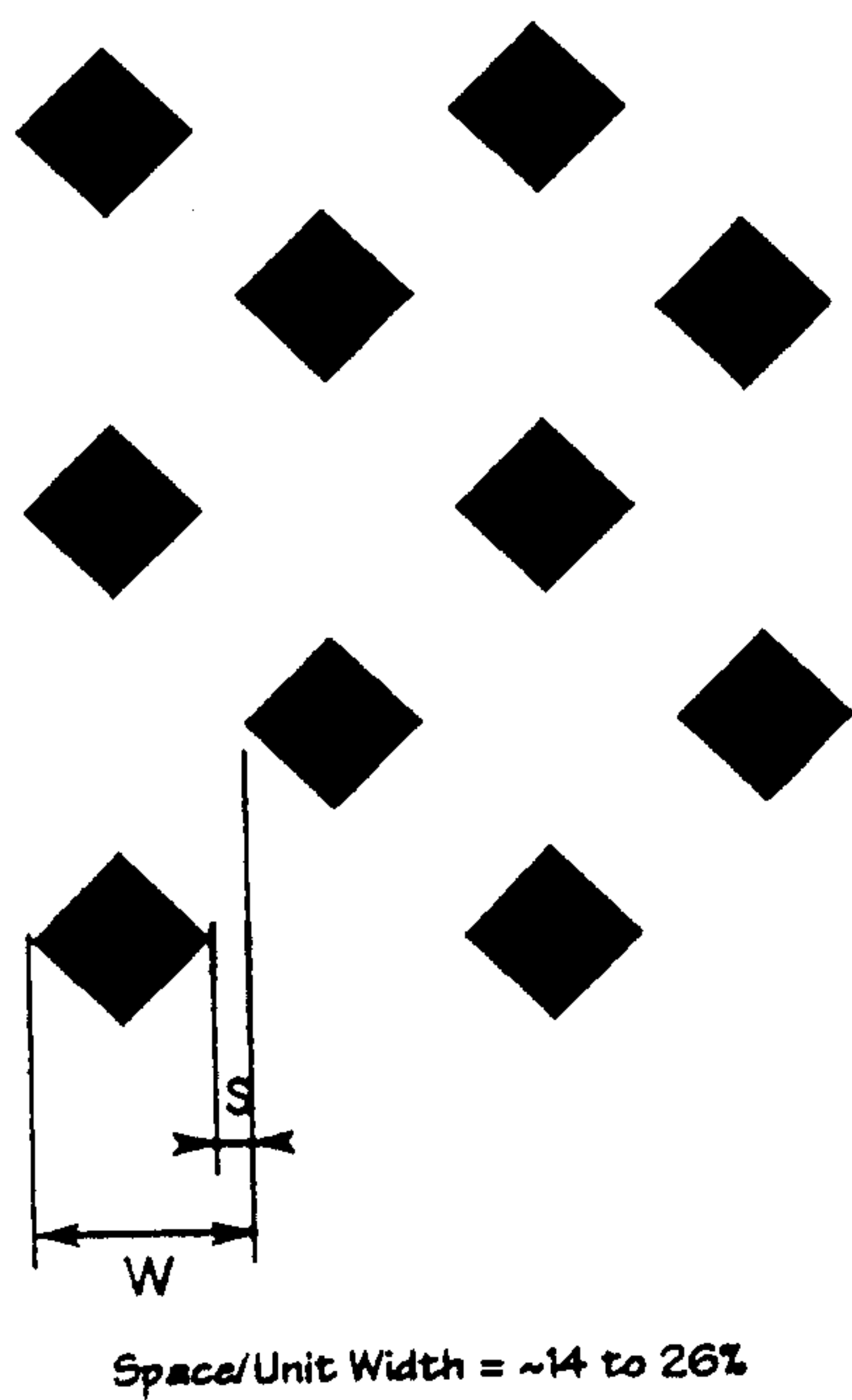
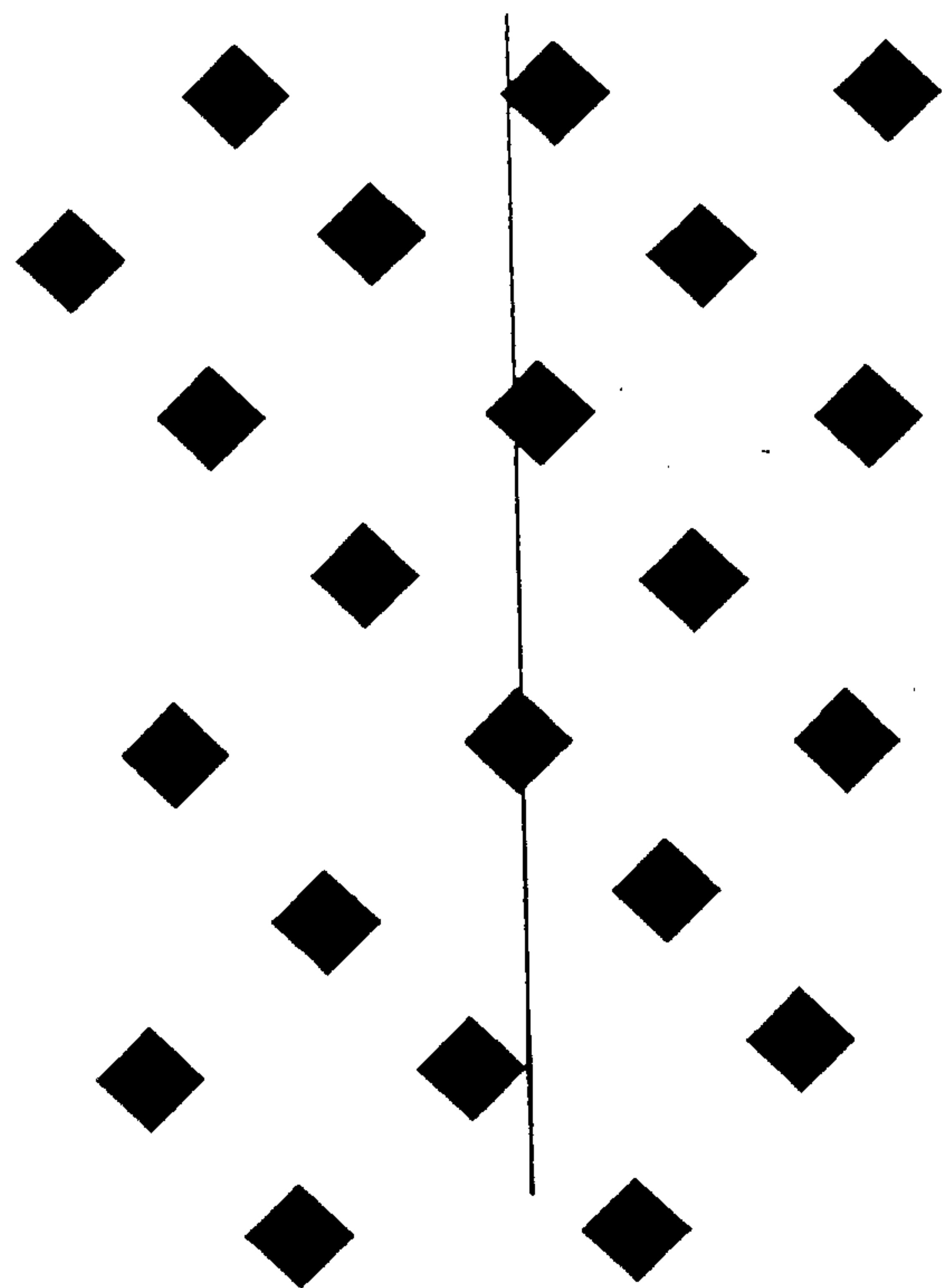


Figure 10

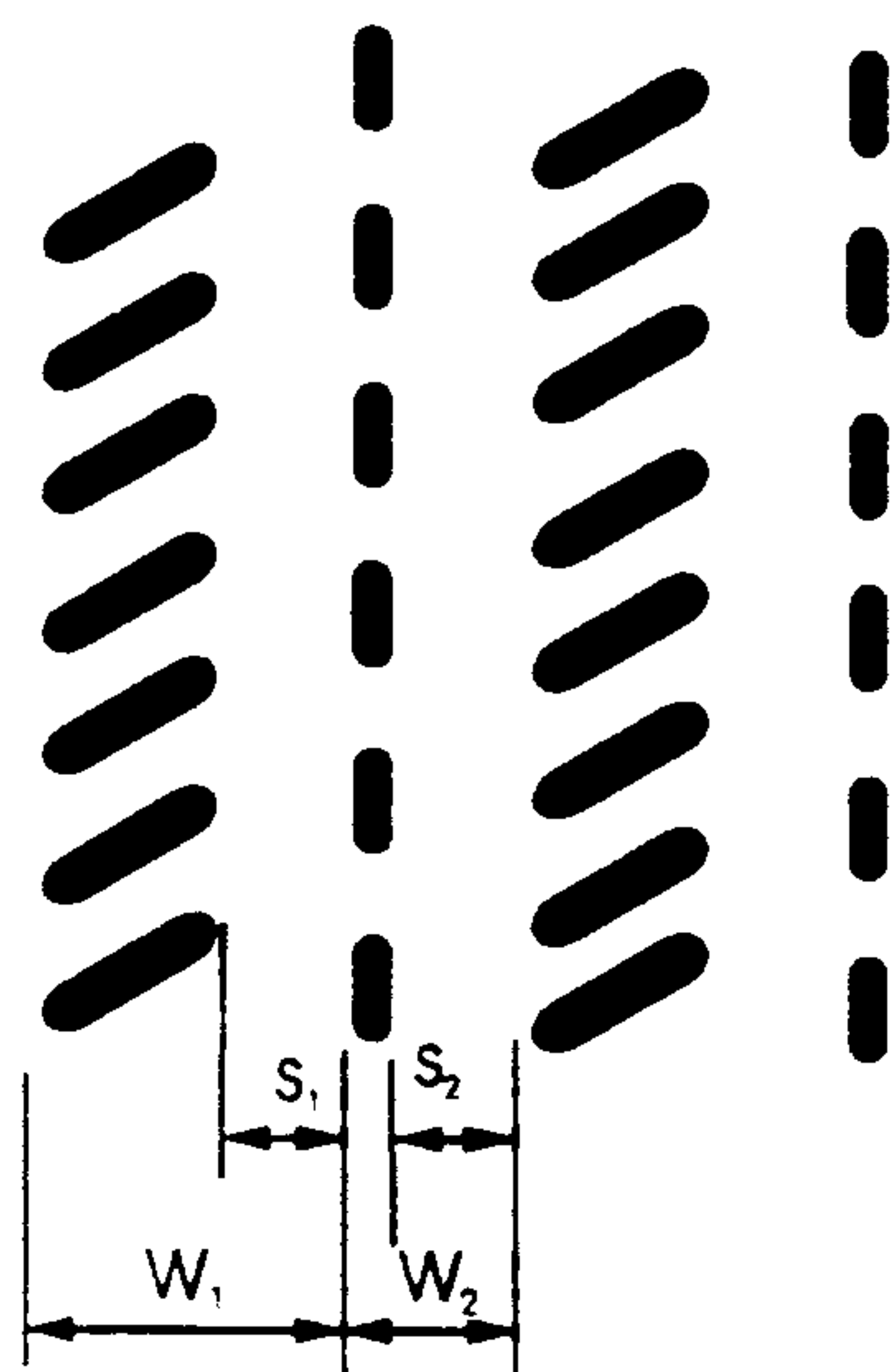
Prior Art



Staggered pattern allows no machine direction spaces

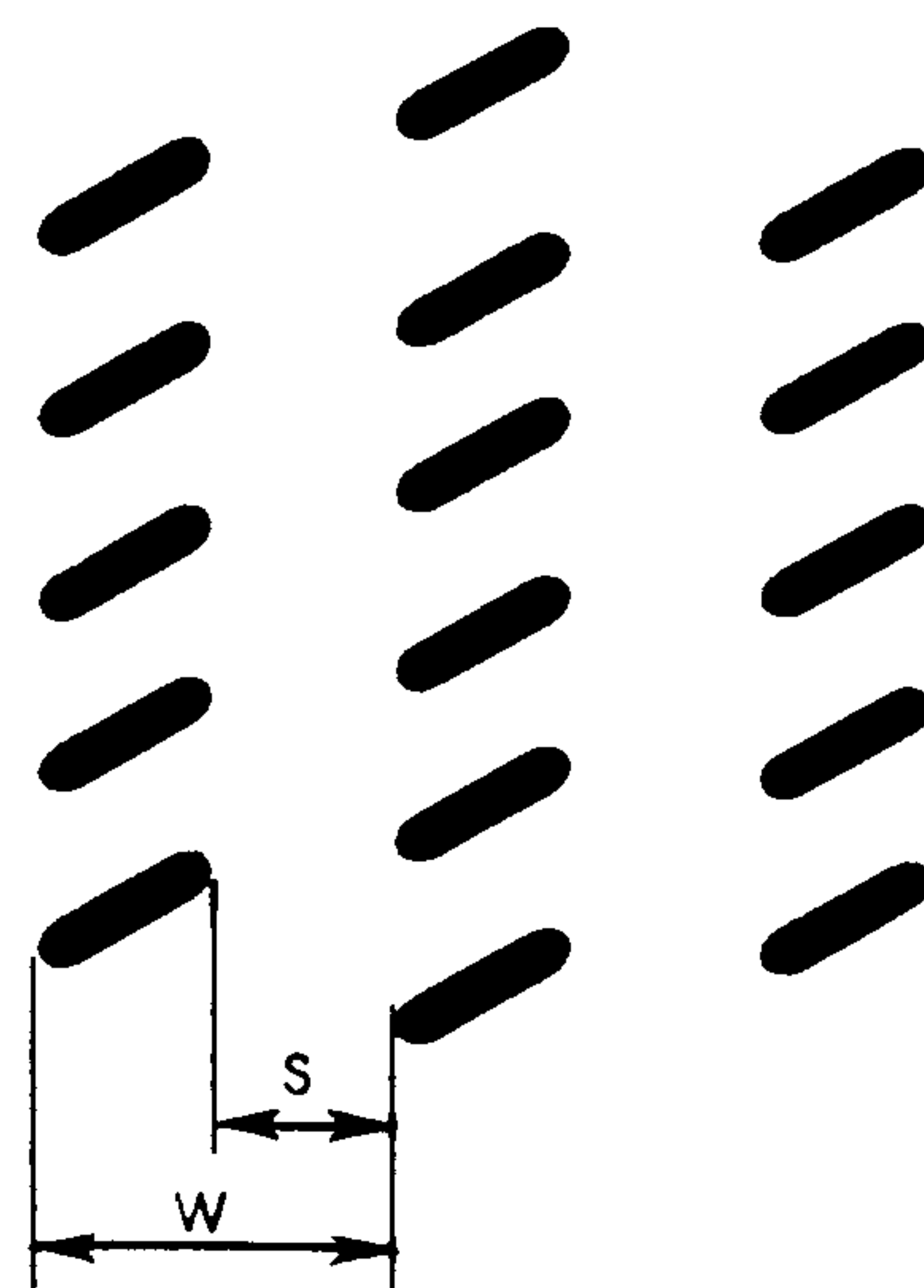
Figure 11

Prior Art



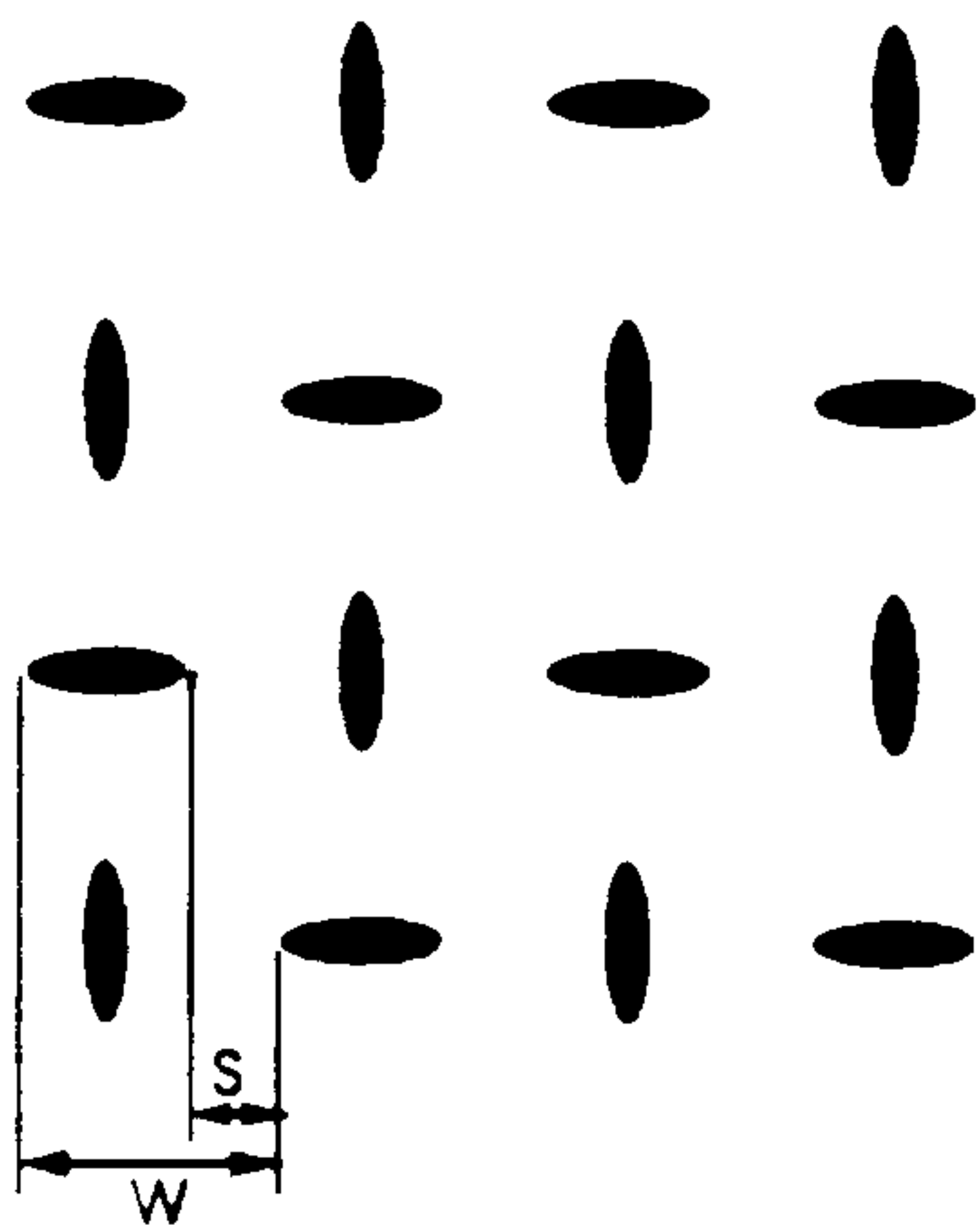
Space $S_1 = S_2$
Space / Unit Width $W_1 = \sim 50\%$
Space / Unit Width $W_2 = \sim 70\%$

Figure 12



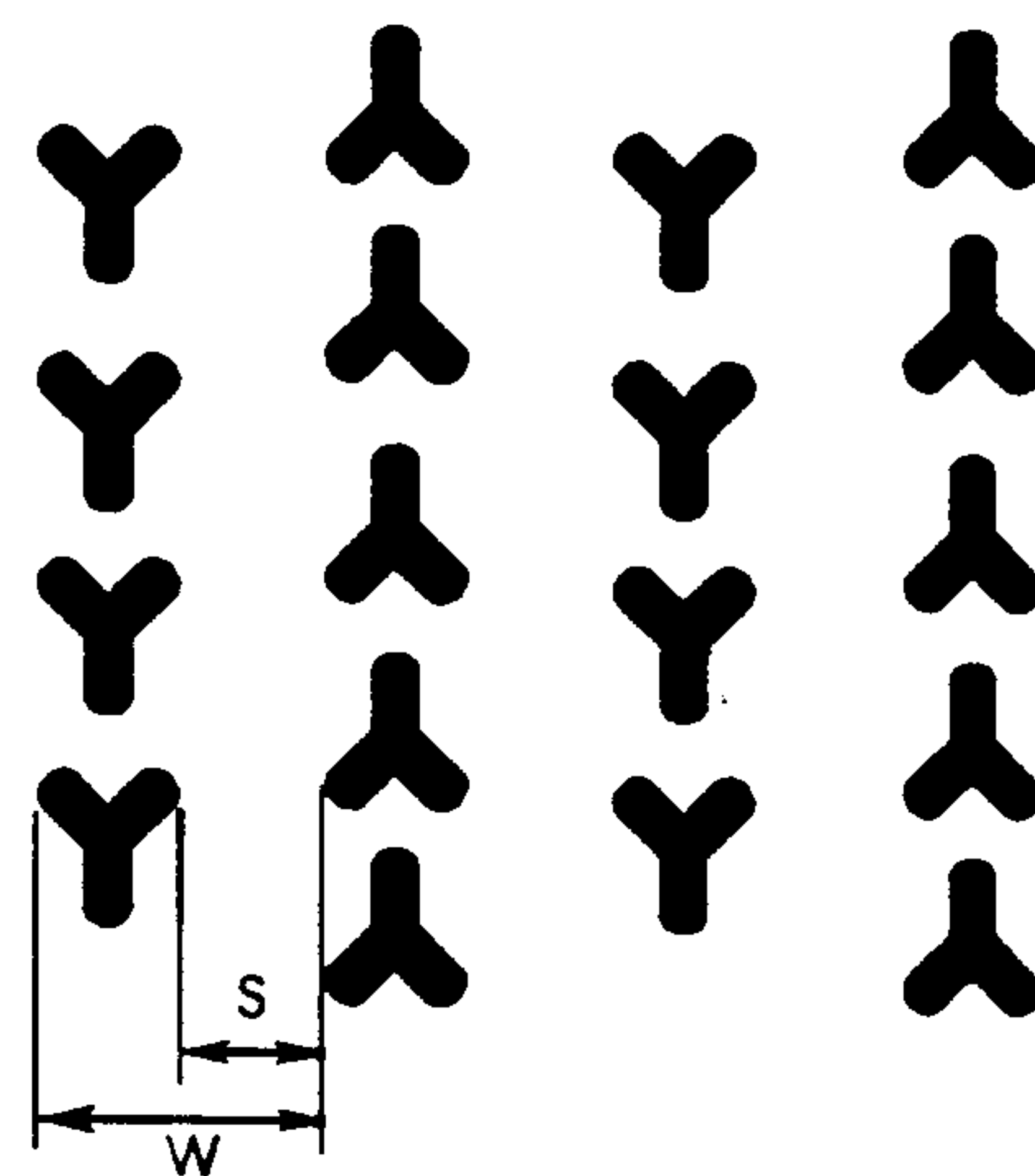
Space (S) / Unit Width (W) = $\sim 50\%$

Figure 13



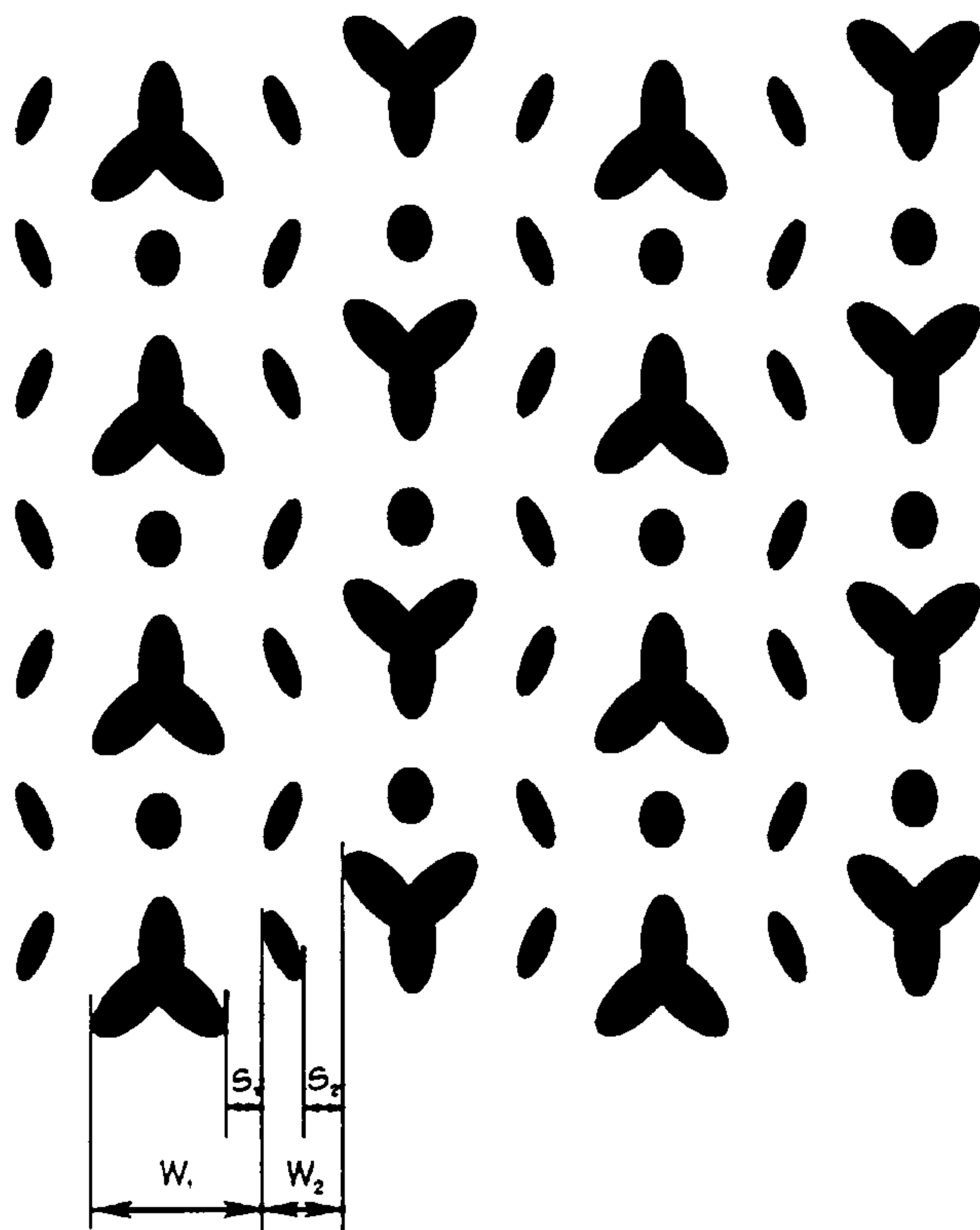
Space (S) / Unit Width (W) = $\sim 45\%$

Figure 14



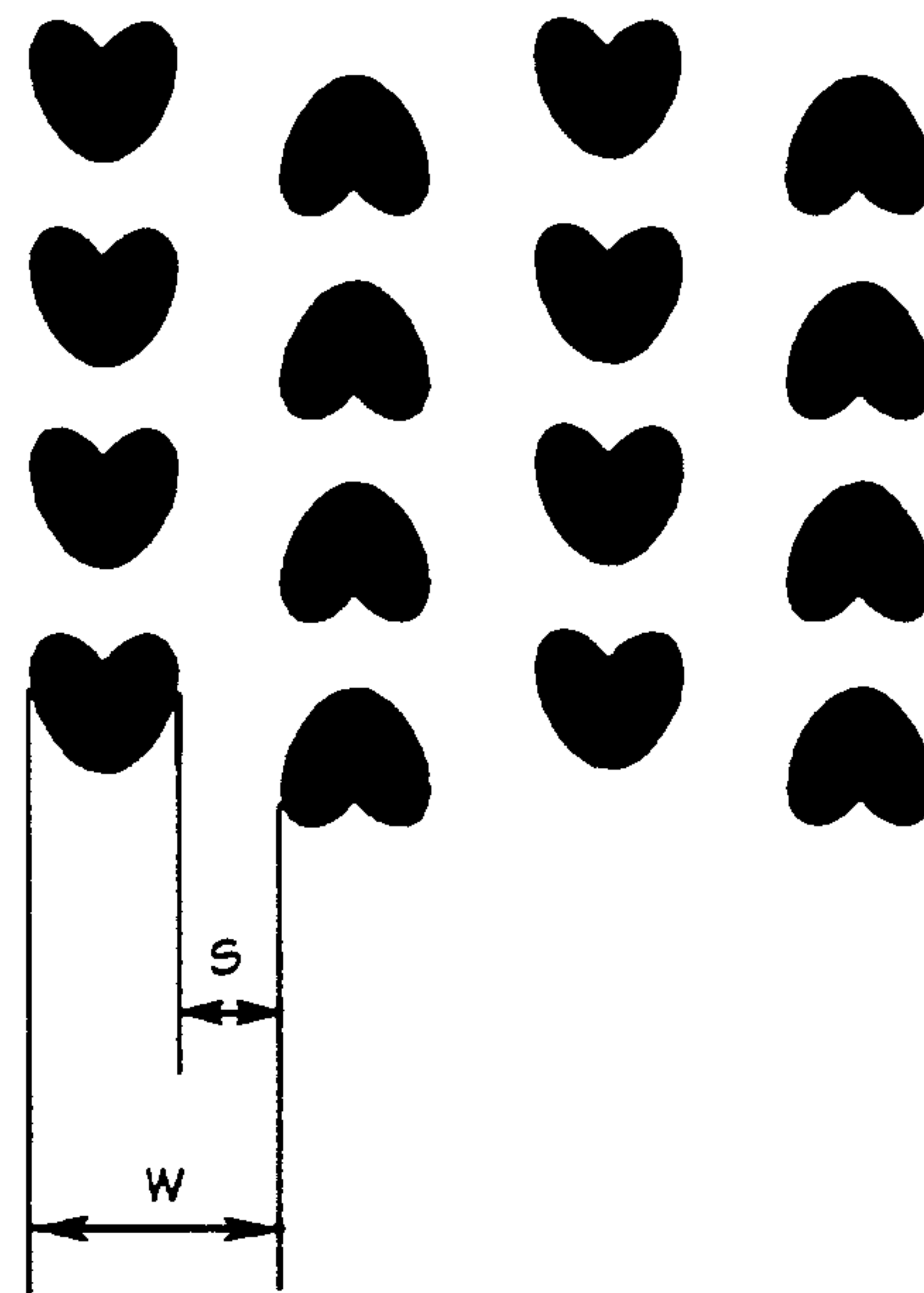
Space (S) / Unit Width (W) = $\sim 50\%$

Figure 15



Space $S_1 = S_2$
 Space/Unit Width $W_1 = \sim 21\%$
 Space/Unit Width $W_2 = \sim 50\%$

Figure 16



Space (S)/Unit Width (W) = $\sim 40\%$

Figure 17

