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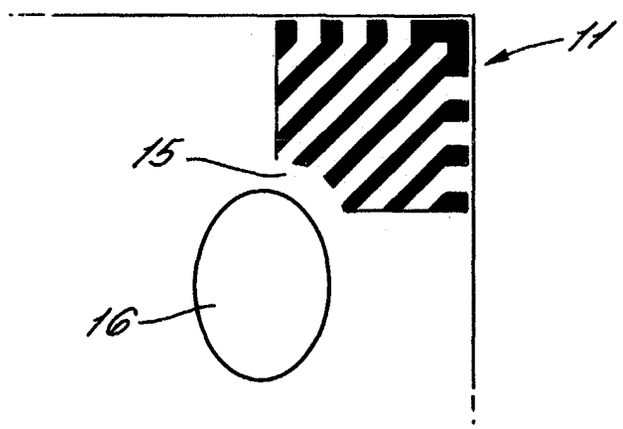
(54) Corner reinforcing watermarks on sheets

(57) The invention relates to improvements in paper, and in particular to the use of watermarks alone or with embossings for strengthening paper sheets and documents made therefrom. The invention therefore provides a sheet having corners and sides joined at said corners, wherein corner reinforcing watermarks are provided at at least two of said corners, and at least one of which reinforcing watermarks has a border, at least a section of which has a complementary shape with respect to and is located close to at least a section of a border of a further watermark. The watermarks may additionally or alternatively be provided with embossings in a pattern dissimilar to that or the reinforcing watermarks.

FIG. 9.



EP 1 466 755 A2

Description

[0001] The invention relates to improvements in sheets, and in particular to the use of a security feature which can be verified by rubbing together two parts of the sheet and documents made therefrom.

[0002] Folded or bent corners (dog-ears) on banknotes present a significant problem for many banks, as they can cause problems in cash handling machines and can result in an artificially short note life. Many machines will reject such notes from circulation. One major European central bank has indicated that 80% of the rejections from their machines are due to such corner folds. Notes with folded corners can also be problematic in ATMS and cash dispensers and other note handling equipment. This is becoming a more significant problem as the use of such machines is becoming more and more widespread.

[0003] Efforts have been made to resolve this problem by providing note handling equipment with apparatus for flattening banknotes to enable a dog-eared or curled document to be fed without jamming. Such a system is described in US-A-5,265,856.

[0004] Another problem which occurs with banknotes in particular results from the tendency of users to roll and fold notes for storage or keeping in wallets and purses. This gives rise to damage at the middle of the edges of the notes and similar problems arise in ATMs and other note handling equipment as occurs with dog-ears and corners.

[0005] In addition to dealing with the aforementioned problems, bank notes and other bank notes and other security require security features that can be easily recognised and verified by the public without the need for additional verification devices. Security devices of the type described herein are intended for use on documents of value including but not limited to banknotes, fiscal cheques, travellers cheques, fiscal stamps, postal stamps, certificates of authenticity, brand protection articles, bonds, certificates, vouchers and the like.

[0006] It is widely accepted that when producing security documents a range of security features is required. This is both to overcome the efforts of counterfeiters and to enable inspection of the documents at a number of different levels. It is usual to consider the inspection of security documents to fall into one of three categories, public, teller assist and covert.

[0007] Inspection of documents at a public level requires the feature to be overt or not to require additional aids to verify. Examples of public features include windowed and embedded threads, cylinder mould watermarks, holographic foils and stripes, intaglio print, colourshifting or optically variable inks, thermochromic features, embossed or printed latent features. All these features will be familiar to those skilled in the art and they are also widely discussed within the patent prior art. It is important to note that several of the above features are not apparent until viewed or handled in the correct manner, e.g. latent images. Such features though not overt can still be authenticated using the human senses and handling alone and do not require the use of a secondary device or piece of equipment.

[0008] Teller assist features require the use of an additional device or piece of equipment to verify the feature. It is usual that the additional device is hand held and low cost but this is not always the case. Examples of teller assist features include luminescent inks, microprint, magnetic inks (where only presence is determined), barcodes, RFID devices and the like. Again those skilled in the art will be aware of such features and examples are widely reported within the prior art.

[0009] Covert features are usually highly secure and only detected using specialised equipment. Examples of covert features include coded magnetic threads, phosphorescent materials and specialist taggants that may be based on biological markers or specific chemical properties.

[0010] It is therefore an object of the present invention to provide a simple and effective security feature which can be verified without the need for additional apparatus.

[0011] The invention therefore comprises a sheet having corners and sides joined at said corners, wherein corner reinforcing watermarks are provided at at least two corners, and at least one of which reinforcing watermarks has a border, at least a section of which border has a complementary shape with respect to and is located close to at least a section of a border of a further watermark.

[0012] The invention also provides a sheet having corners and sides joined at said corners, wherein edge reinforcing watermarks are provided at or covering the middle of at least two sides, at least one of which reinforcing watermarks has a border, at least a section of which border has a complementary shape with respect to and is located close to at least a section of a border of a further watermark.

[0013] In addition to the resistance to corner and edge folds provided by the reinforcing watermarks, the enhancement of the visible close juxtaposition of two watermarks provides an additional visual security feature.

[0014] The invention also provides a benefit in that the corner reinforcing watermarks help to even out the undulations normally present in a ream of paper containing security elements or other security features which, when stacked, create addition bulk.

[0015] The invention also provides a sheet having corners and sides joined at said corners, wherein corner reinforcing watermarks are provided at at least two corners, at least a portion of the reinforcing watermarks being embossed to provide embossings having a pattern dissimilar to that of the reinforcing watermarks.

[0016] The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Fig. 1 is a representation of a small sheet of paper, such as a banknote, having corner reinforcing watermarks;

Fig. 2 shows different watermarks used for tests;

Figs. 3, 4 and 5 show test results for various tests showing the improvement provided by the invention;

Figs. 6 to 8 show further alternative patterns for corner reinforcing watermarks;

Figs. 9, 10 and 10a show one of the corner reinforcing watermarks cooperating with another watermark;

Fig. 11 is a representation of a small sheet, such as a banknote, having edge reinforcing watermarks;

Figs. 12 to 17 are further alternative patterns for edge reinforcing watermarks; and

Figs. 18 and 19 are representations of sections of cylinder mould covers used in the manufacture of a sheet of paper having corner reinforcing watermarks according to the invention.

[0017] Referring to Fig. 1 there is illustrated a sheet of paper 10 made by hand or using a known papermaking machine, such as a cylinder mould or Fourdrinier machine. A range of fibre types can be used in the making of such paper, including synthetic or natural fibres or a mixture of both. The actual preparation of the fibres is unrestricted by the invention, and will depend on what effect it is wished to produce in the finished paper. For security paper used for security documents such as banknotes, passports, identification cards and so on, these need to be hard wearing, resilient and self-supporting and so an appropriate fibre mix must be selected.

[0018] It should be noted that, in this specification, "a sheet" can refer to a large sheet of paper which is cut into smaller sheets from which documents, such as banknotes, are made; or are such smaller sheets.

[0019] For clarity, the reference to "sides" means the elongate edges joined at the corners of the sheet, rather than the flat planar surfaces (or faces) of the sheet.

[0020] According to the invention watermarks 11 are provided in at least two, preferably adjacent, of the corners of the sheet 10 during the manufacture of the paper. A watermark is created by well known techniques of varying the grammage of paper fibres so that in some areas the fibres are of higher grammage than the average grammage of the base paper layer, and in others they are of lower grammage. When viewed in transmitted light the areas of lower grammage are lighter and the areas of higher grammage are darker than the base paper, and the contrast between the light and dark areas can be very clearly seen.

[0021] Watermarks have been widely used as security features, as true watermarks are very hard to counterfeit particularly by photocopying techniques. They are also used as aesthetic features, e.g. in stationery, as complex patterns can be produced by watermark techniques. Traditionally watermarks have always tended to be located in the main body of the sheet or document in which they are produced so that they can clearly be seen. In the present invention, on the other hand, the watermarks are specifically located in the corners of the sheet. This has resulted in the surprising increase in stiffness of the corners which leads to a significant and unexpected reduction in corner folds'(dog-ears).

[0022] In particular it has been found that watermarks that locally increase the grammage of the paper in the corner of the document significantly reduces its propensity to form dog-ears by increasing the stiffness in this area. One reason for this increase is because of the increase in the stiffness of the paper. It is well known, according to classical beam theory, that the stiffness of an object is proportional to the cube of its thickness, as described in "Pulp and Paper Technology and Treatments of Paper", 1978, page 74 by J d'A Clark, Freeman Publications Inc, San Francisco. Small increases in thickness do thus result in a significantly largely benefit in terms of stiffness. A typical stiffness measurement would be the L&W test as specified in ISO 2493.

[0023] Another particularly effective watermark pattern is one that results in lines of higher grammage areas approaching the edges of the paper at between 55° an 35° to the edge perpendicular, and more preferably at 45°.

[0024] In tests carried out using handmade paper made using a specially prepared hand sheet mould, which was embossed with seven different patterns, it was found that corner reinforcing watermarks could increase the stiffness of the paper by over 50% in the corners. The patterns tested are shown in Fig. 2. These are marked for convenience as patterns A, B, C, D, E, F, G and a blank control as H. The L&W stiffness was measured at 45° to the vertical on the finished note and the results for each of the patterns as shown in Figure 3.

[0025] Figure 4 shows the results for a test developed for this study. The test gives an angle to which a fold relaxes after it has been bent over with a known force. In this case, whether other factors are constant, the watermark increases the fold recovery angle because of the stiffness imparted by the watermark pattern. The results of the specific patterns of Figure 2 are shown in Figure 4.

[0026] A further experiment was carried out to determine the probability of forming corner folds (dog-ears) and the results of this test are shown in Figure 5. Again these results show the severity of the fold, shown as "dog-ear index" is least for the six stripe pattern F. It was found that the pattern F was the most effective. This was

where the watermark comprised a wide stripe pattern with the stripes at substantially 45° to the machine direction (the edges of the sheet 10). The preferred width of the stripes used in the tests was in the range of 1 to 2mm wide and most preferably 1.5mm wide. The second most effective pattern was A which had wavy lines of 2mm width.

[0027] The tests showed that the orientation of the elements making up the watermark design is important to give the optimum strength in the direction in which corner folds are likely to form, i.e. 45° to the machine direction.

[0028] It was found that the stiffness of the paper increased where the watermark was made from a positive pattern having the effect of adding bulk to selected areas as compared to the thickness of the base paper layer, as opposed to a negative pattern where the main portion was thinner than that of the base paper layer.

[0029] Not only was the stiffness of the paper found to be increased in the paper made according to the invention, but in tests to measure fold recovery angle, it was found that the improvement in fold recovery was as much as 50% over paper without corner reinforcing watermarks.

[0030] Additional patterns which have proved to be effective in trials are illustrated in Figs. 6 to 8.

[0031] In addition, the corner reinforcing watermarks 11 can be combined with another watermark to enhance the security and aesthetic effect of the sheet. As shown in Figures 9 and 10 at least one of the corner reinforcing watermark 1 has a shaped border 15 (which is not necessarily a contiguous border), at least a section of which is complementary to a portion of a border of a further visible watermark 16, such as a portrait watermark.

[0032] The aforementioned shaped section of border 15 allows the close juxtaposition of the two watermarks 11,16 to provide an aesthetic combination and space saving. This results in an improvement in security by using close registration and cooperation of the two watermark features 11,16, which makes it hard to counterfeit. The gap between the two watermarks 11,16 is preferably no less than 3mm and more preferably in the range of 3 to 5mm.

[0033] It should be noted that the border 15 can include an internal border; and the further visible watermark 16 may be wholly surrounded by the corner reinforcing watermarks, as shown in Figure 10a.

[0034] In a further embodiment of the present invention, watermarks 12 are created either at, or covering, the middle of each edge of the sheet 10, i.e. at North, South, East and West positions of the note when viewed face on. The problems identified previously relating to damage at the middle of each of the edges of banknotes have been found to be significantly reduced by providing such reinforcing watermarks at the middle of each edge, as shown in Fig. 11, because of the increased stiffness and improved fold recovery in these regions. Again, the watermarks 12 are preferably positive and the preferred form include corrugations and/or elements of the design perpendicular to the likely direction of folding or rolling, i.e. parallel to the edges of the sheet 10.

[0035] These edge reinforcing watermarks are also enhanced by providing one of its borders with at least a section which complements at least a section of a border of a wide watermark indicia 16, to which it is closely positioned.

[0036] Notes which have both corner and centre edge reinforcing, for example a combination of the pattern shown in Figs. 1 and 11 are preferred, and one of each can be arranged with an adjacent visible watermark 15.

[0037] The individual reinforcing watermarks 11, 12 may be discrete, as illustrated in Figs. 1 and 11, or they may be joined together so that the watermark appears as a continuous frame around the whole sheet 10. Alternatively just some of the reinforcing watermarks 11, 12 may be joined, to provide an aesthetic pattern.

[0038] It should be noted that machine made paper is produced in continuous webs, which is subsequently cut to form individual smaller sheets. Obviously the pattern of reinforcing watermarks 11, 12 produced on the web will need to be carefully designed to ensure that when the sheet 10 are cut, the watermarks 11, 12 are located at the corners and/or edges of the sheet 10.

[0039] In a further embodiment of this invention it has been discovered that the effective thickness of the paper in the document corners and/or at the edges can also be increased by providing embossings, preferably in the form of corrugations, at the corners or the edges having the reinforcing watermarks 11,12 in patterns similar to those of the reinforcing watermarks 11,12. Embossing can preferably be achieved by the intaglio printing process commonly used for printing security documents. These embossings can be used in addition to, or instead of the combination of the complementary combination of watermarks described above, to provide an improved security feature.

[0040] When this combination of techniques was applied in tests to banknotes, corner stiffness increases of up to 250% were achieved, as measured by the L&W stiffness tester. The embossing also provide a useful tactile security check.

[0041] It is well known that security documents in general, and banknotes in particular, can be embossed using the intaglio printing process. Embossing without the application of ink is sometimes used with a view to producing tactile security features as found on the Dutch 10 Guilder notes issues in 1997. These notes have a series of chevron patterns down the short edges of the notes. Testing carried out on these notes have shown that no improvement in corner fold stiffness was achieved by these embossings. The reason for this is that they are not positioned correctly to achieve such an effect being too far from the paper edge and the lines being too narrow.

[0042] The embossings may be produced by an intaglio process, either with or without (blind) ink. The em-

bossings preferably fill an area bounded by at least a length of 10mm on each of the adjacent sides of each corner. More preferably the whole of each corner area is filled. The embossings preferably consist of a plurality of stripes, each having a width between 0.5 and 3mm wide which are separated by gaps having a width lying in the range 0.5 to 3mm. The stripes may be straight, wavy or curved and are preferably parallel.

[0043] The stripes of the embossings are preferably at an angle of between 70° and 111°,relative to the line of a corner fold set at 45° to one of the edges, and more preferably at an angle of 90°.

[0044] Alternatively the embossings may be provided by uninked die stamping.

[0045] The document may be varnished on one or both surfaces to improve durability of the embossings. Additionally the substrate may be coated on one or both surfaces to improve the durability of the substrate. The embossed regions may be reinforced using a varnish layer on the front, or back of the embossing or on both the front and back of the embossing.

[0046] It is known that cross directional shrinkage of the paper during the papermaking process is greater at the edges of the paper web than in the centre. To allow for this shrinkage profile, while maintaining the dimensions of the document, the forming cloth may be embossed with the reinforcing watermarks overlapping (Figure 16) or adjacent (Figure 17) or at any desired position between.

Claims

1. A sheet having corners and sides joined at said corners, wherein corner reinforcing watermarks are provided at at least two corners, and at least one of which reinforcing watermarks has a border, at least a section of which border has a complementary shape with respect to and is located close to at least a section of a border of a further watermark.

2. A sheet having corners and sides joined at said corners, wherein edge reinforcing watermarks are provided at or covering the middle of at least two sides, at least one of which reinforcing watermarks has a border, at least a section of which border has a complementary shape with respect to and is located close to at least a section of a border of a further watermark.

3. A sheet having corners and sides joined at said corners, wherein corner reinforcing watermarks are provided at at least two corners, at least a portion of the reinforcing watermarks being embossed to provide embossings having a pattern dissimilar to that of the reinforcing watermarks.

4. A sheet having at least three corners and at least three sides joined at said corners, wherein edge reinforcing watermarks are provided at each of said sides, at least a portion of at least two reinforcing watermarks being embossed to provide embossings having a pattern dissimilar to that of the reinforcing watermarks.

5. A sheet as claimed in any one of the preceding claims in which the reinforcing watermarks are positive watermarks.

6. A sheet as claimed in any one of the preceding claims in which the reinforcing watermarks comprise a plurality of stripes.

7. A sheet as claimed in claim 6 in which the stripes are straight.

8. A sheet as claimed in claim 6 in which the stripes are wavy.

9. A sheet as claimed in any one of claims 6 to 8 in which the stripes of the corner reinforcing watermarks substantially extend at an angle of 45° to the sides of the sheet.

10. A sheet as claimed in any one of claims 6 to 9 in which the stripes of the edge reinforcing watermarks are substantially parallel to the sides of the sheet.

11. A sheet as claimed in any one of claims 6 to 10 in which the width of the stripes lie in the range of 1 to 2.5mm.

12. A sheet as claimed in claim 11 in which the width of the stripes lies in the range of 1.5mm to 2mm.

13. A sheet as claimed in claim 1 and claim 2 having corner and edge reinforcing watermarks.

14. A sheet as claimed in claim 3 and claim 4 having corner and edge reinforcing watermarks.

15. A sheet as claimed in any one of the preceding claims in which the reinforcing watermarks are joined by watermark patterns.

16. A sheet as claimed in claim 1 or claim 2 in which embossings are provided overlying the reinforcing watermarks in a similar pattern to the reinforcing watermarks.

17. A sheet as claimed in claim 1 or claim 2 in which embossings are provided overlying the reinforcing watermarks in a dissimilar pattern to the reinforcing watermarks.

18. A sheet as claimed in any one of claims 3 to 17 in which the embossings are provided by an intaglio process.

19. A sheet as claimed in claim 18 in which the intaglio embossings are uninked.

20. A sheet as claimed in any one of claims 3 to 17 in which the embossings are provided by die stamping.

21. A sheet as claimed in any one of claims 3 to 20 in which the embossings fill an area bounded by at least a length of 10mm on each of the adjoining sides of each corner.

22. A sheet as claimed in any one of claims 3 to 21 in which the whole of each corner area of the sheet are filled with embossings.

23. A sheet as claimed in any one of claims 3 to 22 in which the embossings comprise a plurality of the stripes, each stripe having a width lying in the range of 0.5 to 3mm wide and the stripes being separated by gaps having a width lying in the range of 0.5 to 3mm.

24. A sheet as claimed in claim 23 in which the stripes of the embossings are substantially parallel to each other.

25. A sheet as claimed in claim 19 or claim 20 in which the stripes of the embossings are substantially straight.

26. A sheet as claimed in any one of claims 23 to 25 in which the stripes of the embossings are at an angle lying in the range of 70° to 110° relative to the line of corner fold set at 45° to one of the edges.

27. A sheet as claimed in claim 26 in which the stripes of the embossings are at an angle of substantially 90° relative to the line of corner fold set at 45° to one of the edges.

28. A security document made from a sheet according to any one of the preceding claims.

29. A banknote made from a sheet according to any one of the preceding claims.

30. A sheet substantially as hereinbefore described with reference to or as shown in the accompanying drawings.

FIG. 1.

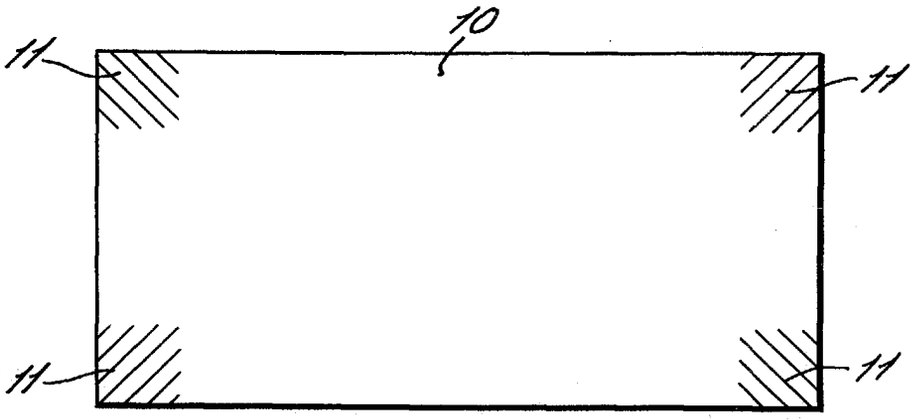


FIG. 2.

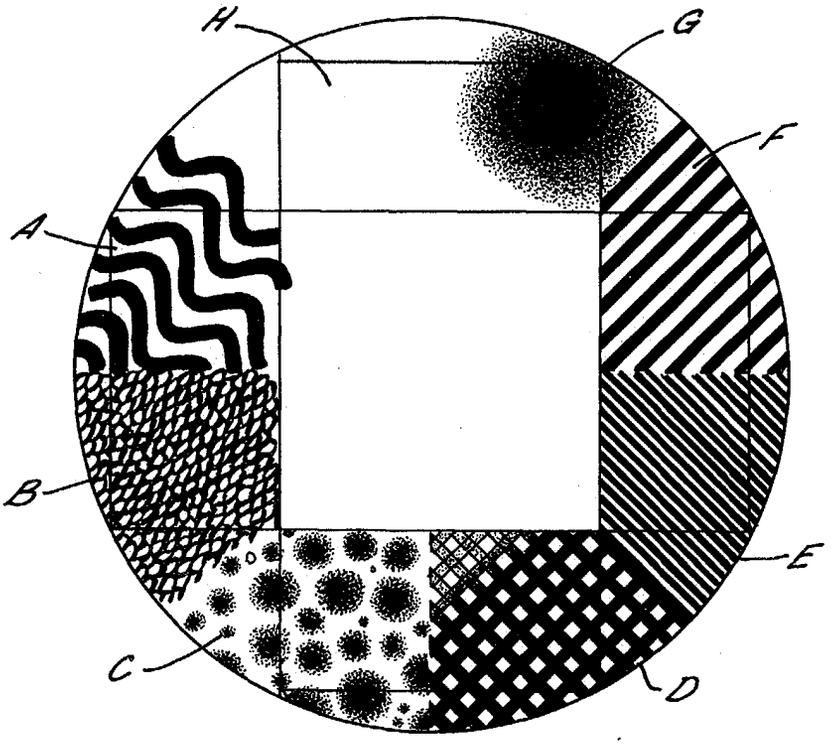


FIG. 3. L & W STIFFNESS

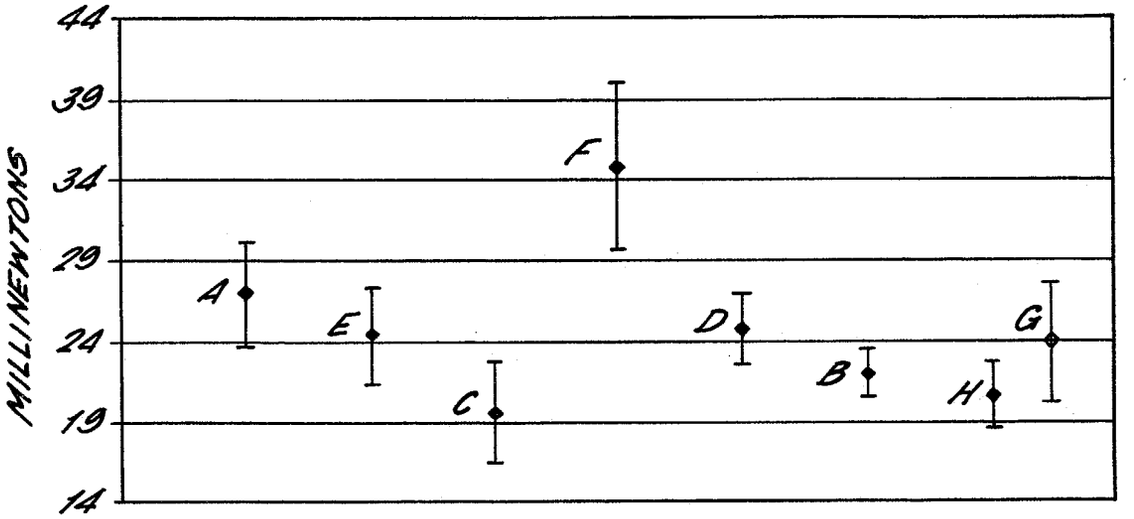


FIG. 4.

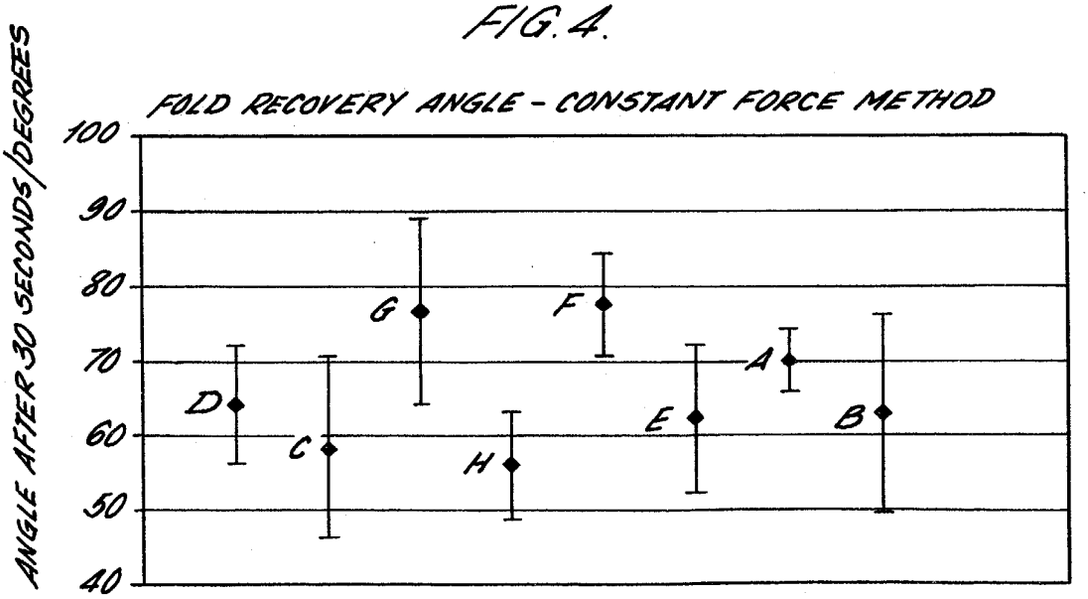


FIG. 5.

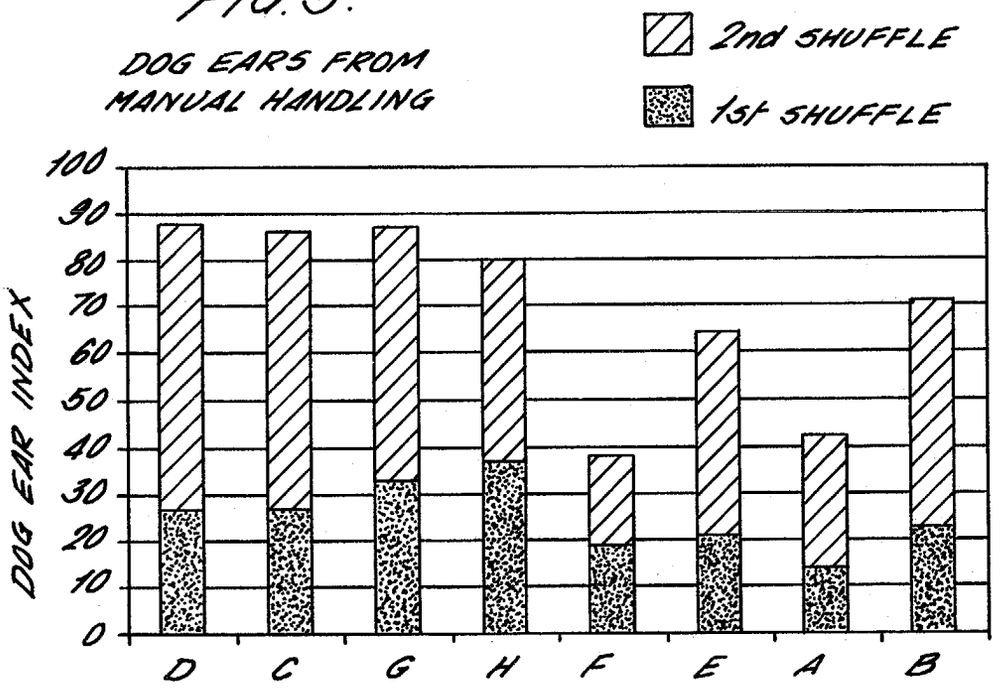

DOG EARS FROM MANUAL HANDLING
2nd SHUFFLE
1st SHUFFLE
DOG EAR INDEX
100
90
80
70
60
50
40
30
20
10
0
D
C
G
H
F
E
A
B

FIG. 11.

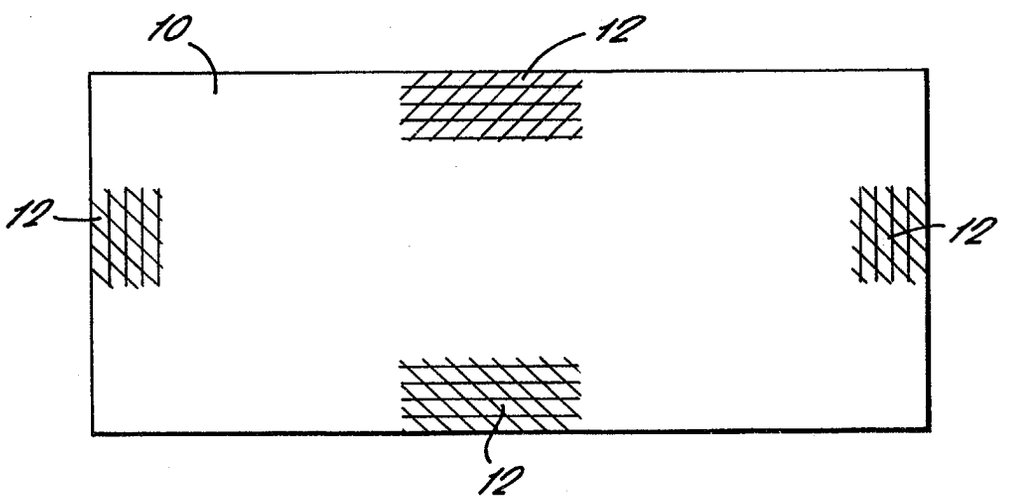

10
12
12
12
12

FIG. 6.

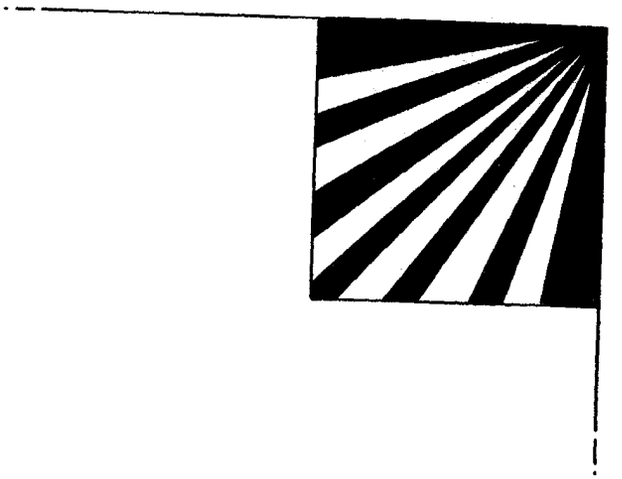


FIG. 7.

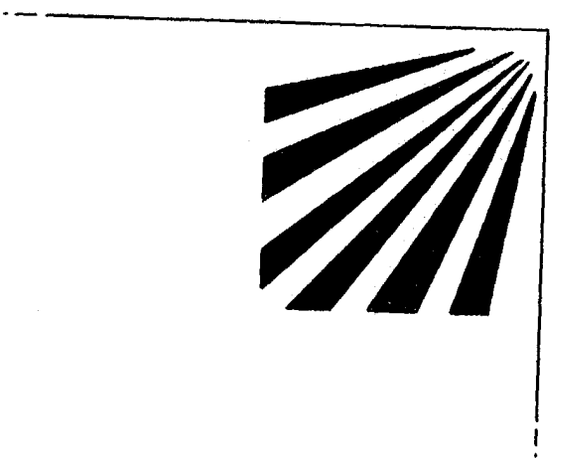


FIG. 8.

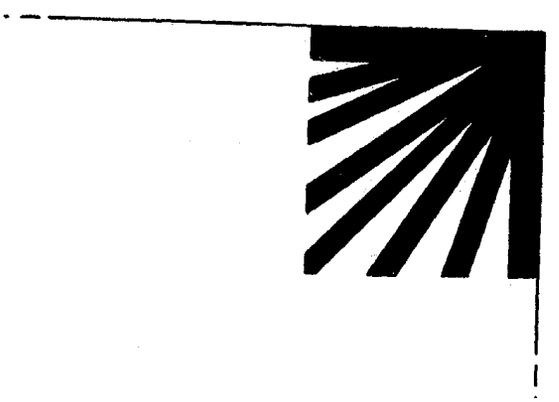


FIG. 9.

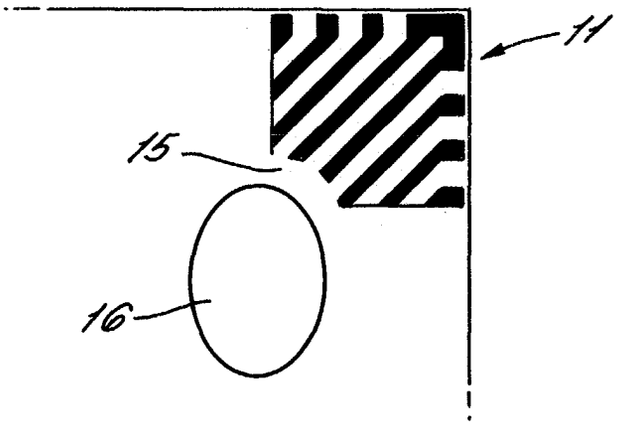


FIG. 10.

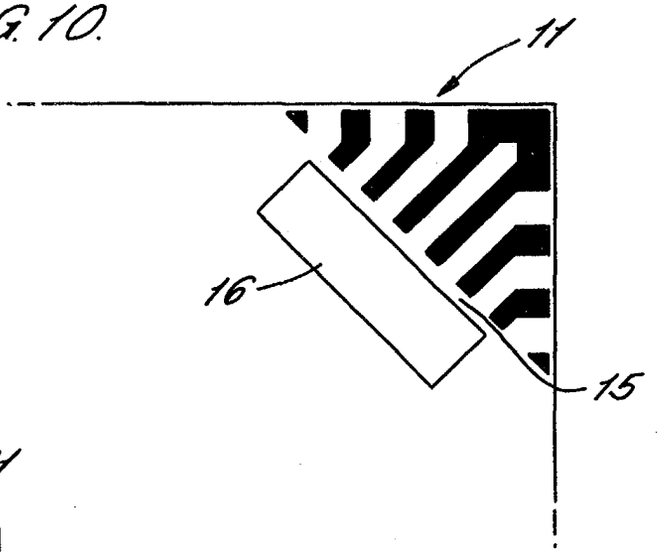


FIG. 10a.

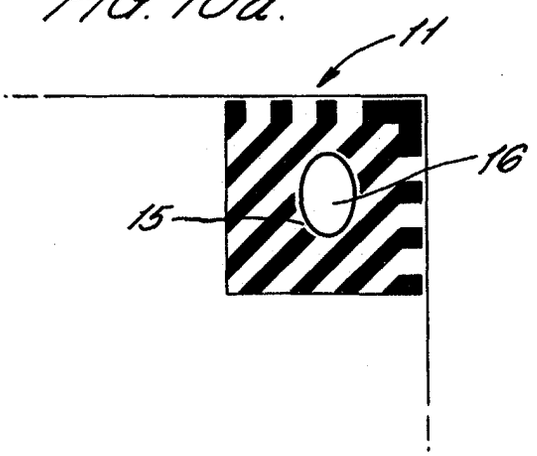


FIG. 12.

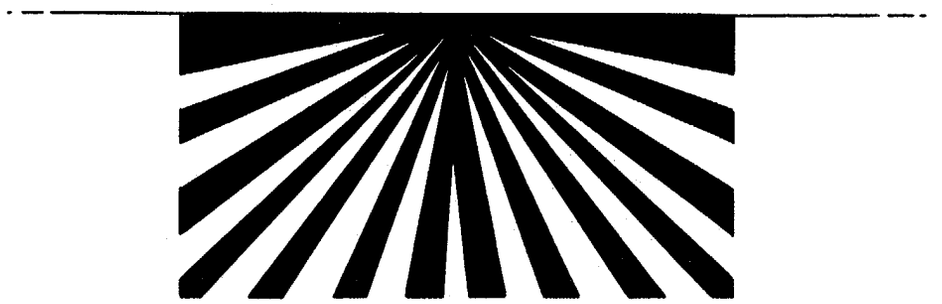


FIG. 13.

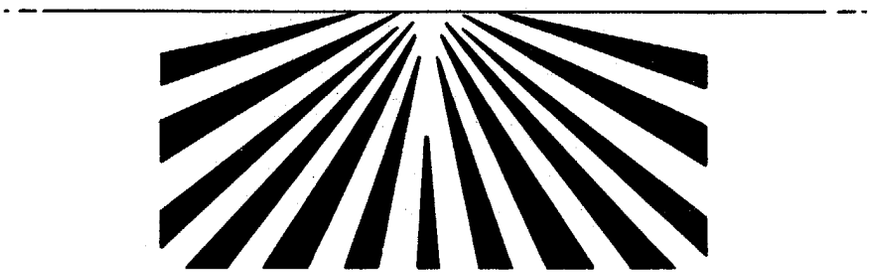


FIG. 14.

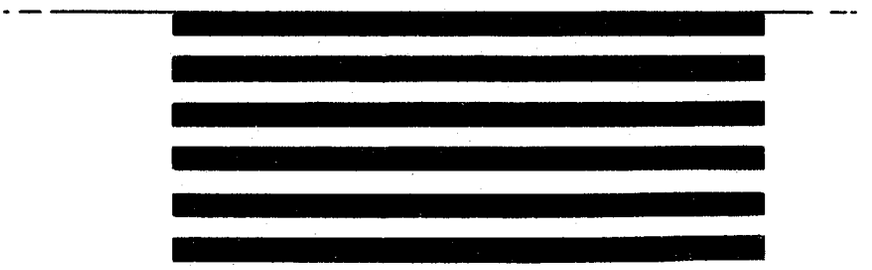


FIG. 15.

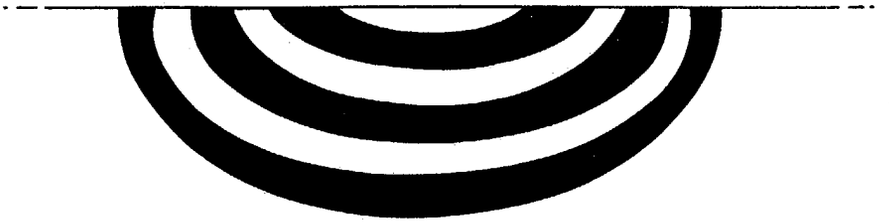


FIG. 16.

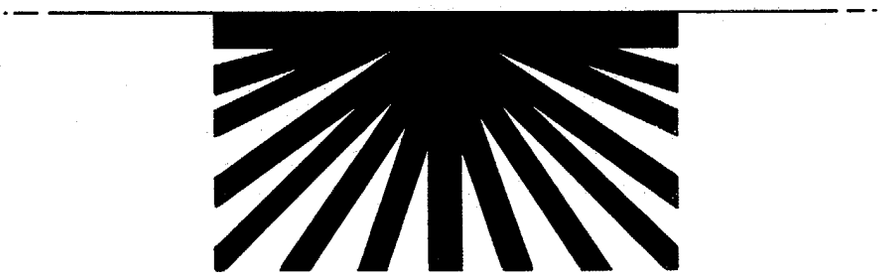


FIG. 17.

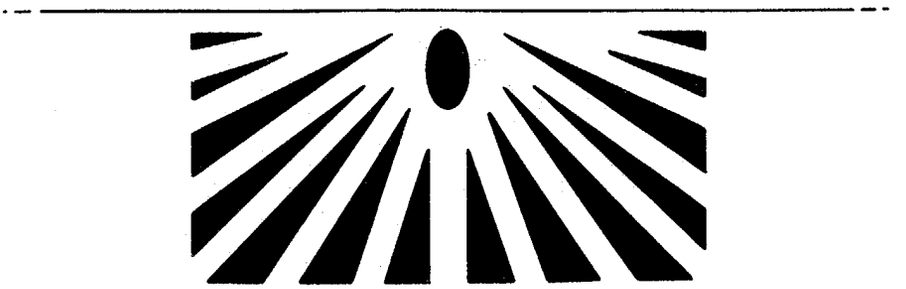


FIG. 18.

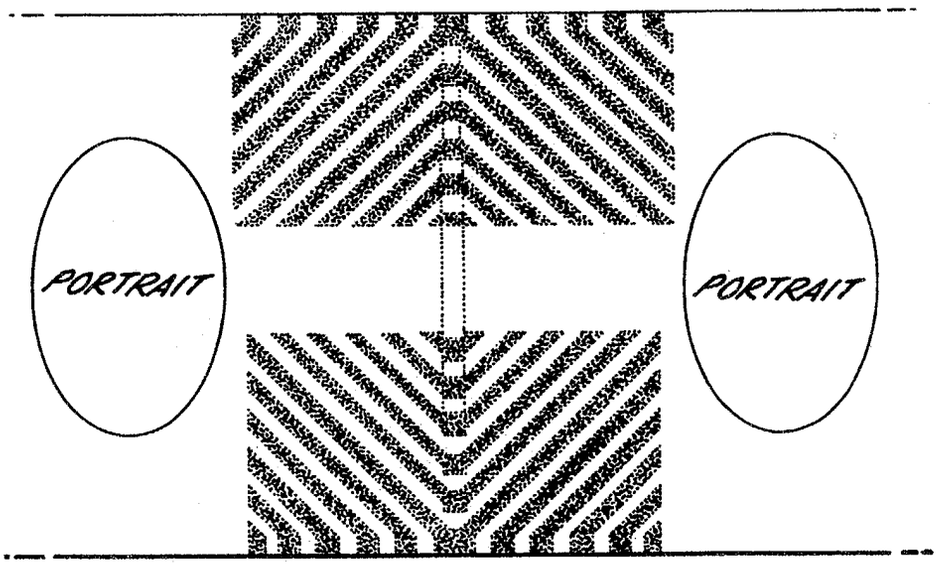


FIG. 19.