FIG. 1.

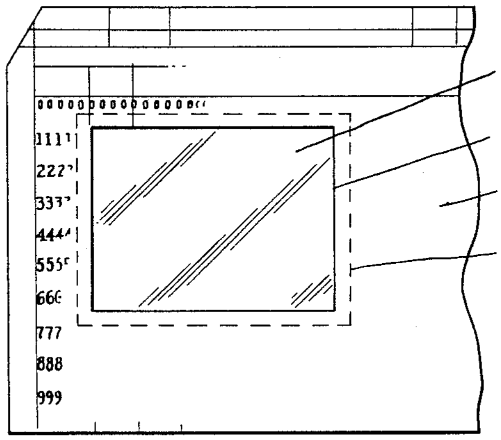
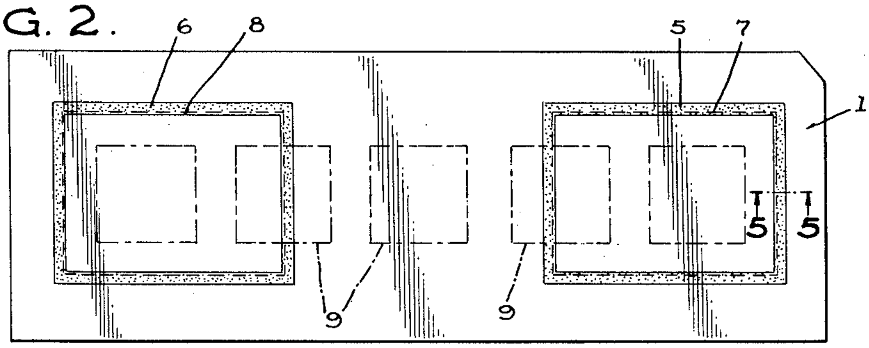


FIG. 2.



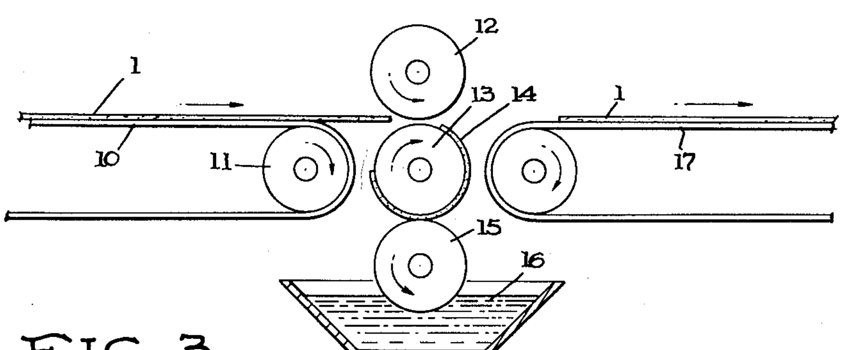
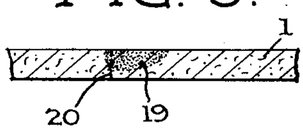


FIG. 3.

FIG. 5.



INVENTOR
JOHN F. LANGAN

BY
Cameron, Kerkam & Sutton
ATTORNEYS

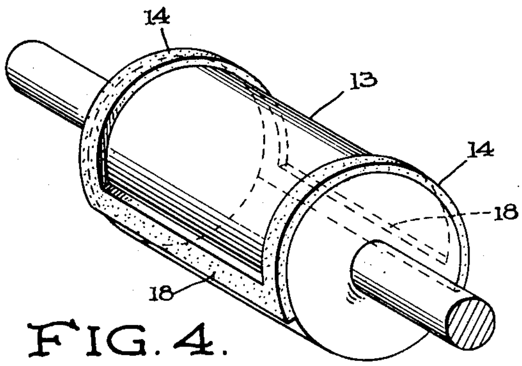


FIG. 4.

FIG. 6.

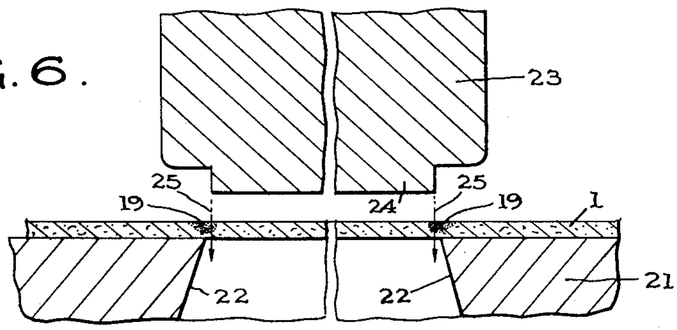
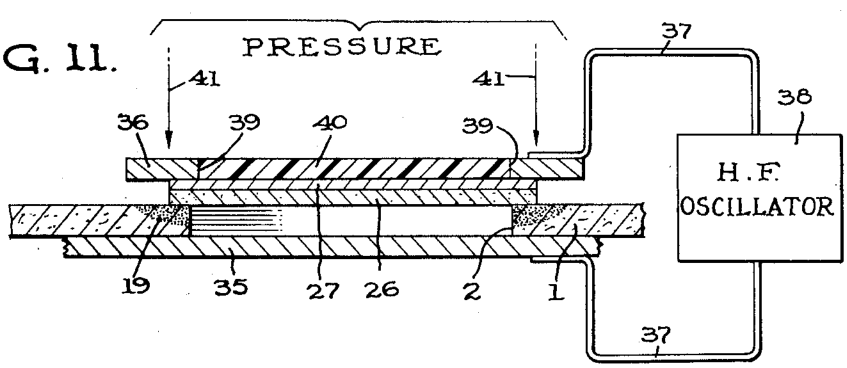


FIG. 11.



INVENTOR
JOHN F. LANGAN

BY
Cameron, Kerkam & Sutton
ATTORNEYS

APERTURE CARD SYSTEM

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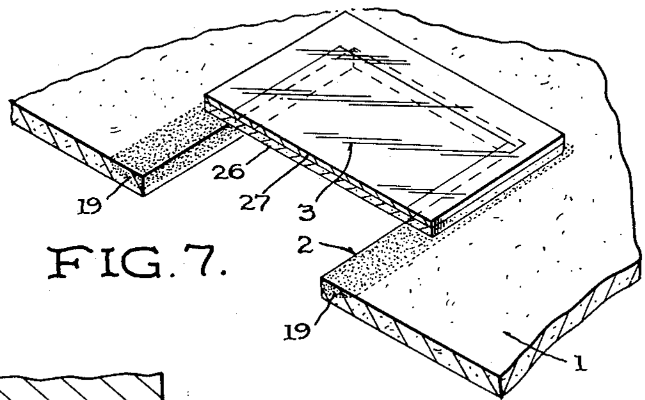

FIG. 7.

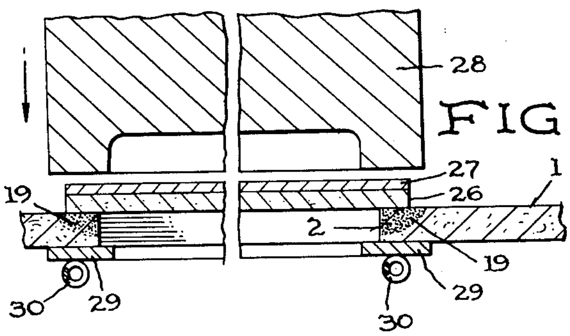

FIG. 8

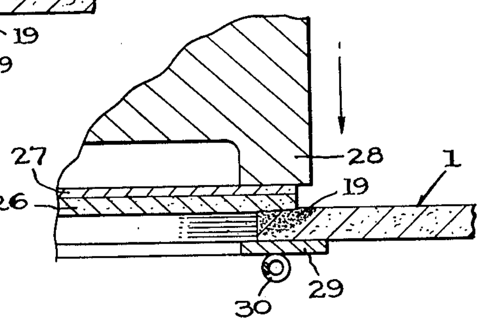

FIG. 9.

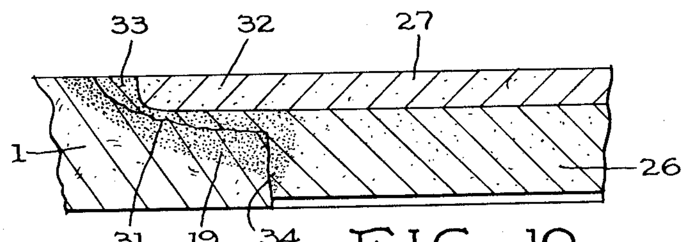

FIG. 10

INVENTOR
JOHN F. LANGAN

BY
Cameron, Kerkam & Sutton
ATTORNEYS

United States Patent Office 3,165,848
Patented Jan. 19, 1965

3,165,848
APERTURE CARD SYSTEM

John F. Langan, Atlanta, Ga., assignor to Langan Aperture Cards, Inc., New York, N.Y., a corporation of Delaware

Filed Nov. 21, 1960, Ser. No. 70,814
2 Claims. (Cl. 40—158)

This invention relates to improvements in mounting transparencies such as individual microfilm sections in film record cards to facilitate the handling, filing and storage of the transparencies, and also the sorting out, projecting and if desired reproducing individual transparencies when desired.

The invention is particularly useful in mounting microfilm sections in cards that are capable of being sorted mechanically, although it is not limited to this use as explained hereinafter. Various types of mechanical sorting systems are well known. The range from systems in which groups of related cards can be separated and extracted from a stack by inserting a pin or the like through aligned holes in the edges of the cards, to the elaborate and well known IBM system in which the cards are perforated according to a code and are sorted by electrically controlled apparatus responsive to the location of the perforations in the individual cards. However, the invention also comprehends the mounting of projectionable transparencies, including all types of photographic film records, in ordinary file cards, catalog cards, and the like.

With reference to machine sorting of the IBM type, the present invention comprises improvements of the "punch cards" or "aperture cards" disclosed in my prior Patents Nos. 2,511,859, 2,512,106, and 2,587,022, as well as in the preparation and use of such cards. Aperture cards of the type shown in these prior patents have been very widely used, especially by the United States Government. By way of example, a current program of standardization of the preparation and distribution of engineering data by this system, such as drawings, specifications and the like, in one particular Government field is estimated to require 90 million aperture cards initially and average annual usage thereafter of 15 million aperture cards.

The merit of such aperture card systems is attested by their widespread adoption and successful use, in spite of serious defects of prior systems which are corrected by the present invention. One such defect has had to do with the "blank" cards as supplied in bulk quantity to the ultimate user, i.e., before the film is mounted therein. As disclosed in my prior Patent No. 2,511,859 mentioned above, these blank cards are supplied already apertured with a strip of adhesive material secured to the backside of the card around the edges of the aperture, a narrow section of this strip extending into the aperture with exposed adhesive thereon for subsequent mounting of a transparency in the aperture. This exposed adhesive is covered by a temporary sheet of glassine paper or similar material.

In the first place, such "blank" cards cannot ordinarily be furnished to a prospective user in large supply because they must be used within a relatively short period or else the adhesive deteriorates to the point where adequate bonding of the transparency cannot be secured. In large part because of this inability to store reserve supplies of blank cards, the common practice has been for the customer to send his microfilm to a central service center where the individual film sections are mounted in the cards. The fact that the customer cannot cut out and mount sections himself, as and when desired, has made for inflexibility in the use of prior aperture card systems and has detracted seriously from their utility and desirability.

The factor mentioned above also makes it practically impossible to use aperture cards for mounting two or more sequential transparencies on the same card, as is often

desirable in order to "post" a record of successive stages of development of a project. In such cases, it is desirable to mount the first transparency in one aperture of a card, and to be able to supplement the original record by mounting a second transparency at some later date in a second aperture of the same card. When the time came for mounting the second transparency, however, the adhesive material around the second aperture would no longer be effective so that a separate card would have to be used.

Another problem arises from frequent sticking together of adjacent cards due either to exposed adhesive in the case of imperfect preparation, or to "bleeding" of the adhesive material from underneath the edges of the protective glassine cover sheet or the edges of the transparency itself. In such cases the separation of blank cards for perforation according to a mechanical sorting code, or for the operations of mounting sections of film therein, or during subsequent use of the finished cards for machine sorting, projection, and the like, is hindered to an extent which militates seriously against the usefulness of such systems.

Furthermore, any increase in thickness of such cards is very undesirable. Even though an applied strip of adhesive may only increase the thickness of a card by an extremely small amount, say 1/1000th of an inch, still when a deck of 1000 or more cards are stacked in a file drawer as is often the case, there will be a difference of an inch or more in the length of one side of the stack as compared with the other.

Still further objections to prior systems arise from the fact that the operations involved in preparing the blank cards, i.e., punching out the apertures and then applying the adhesive strips and the cover sheets, as well as the operations involved in finishing the cards including stripping off the cover sheets and disposing of them and then applying the transparencies to the exposed adhesive strips, both require objectionably elaborate and expensive apparatus such as illustrated for example in the prior Standish Patent No. 2,666,543, the prior Morrison Patents Nos. 2,493,159 and 2,560,301, and the prior Baker Patent No. 2,643,786. Many users of aperture cards have only a relatively small number of transparencies to be mounted at one time, and this only sporadically, so that they cannot justify the expense of purchasing and maintaining such elaborate equipment but must again rely on service centers such as mentioned above.

But perhaps a more basic objection is that the bond between the transparency and the card is not secure enough in many cases. For example, under ordinary conditions of usage, a deck comprising say 1000 cards bearing microfilmed engineering drawings must last for years despite repeated handling incident to removing the cards from and returning them to the drawer, riffling decks of cards before placing them in sorting machines, handling individual cards in projection machines, print copiers, and the like, etc. In the course of such manipulations, the cards are repeatedly subjected to twisting and bending from all possible angles. Unless the bond between the film section and the card is continuous, strong, and permanent, separation of the film from the adhesive may eventually occur with the result that the card must be thrown away and the film section remounted in a fresh blank card.

Added to the above disadvantages is the fact that even though the aperture in the blank card is covered by a temporary removable cover sheet, still the presence of the aperture is undesirable for various reasons. It obviously detracts from the mechanical strength of the blank card, and it may interfere with and hinder the perforation of the card for mechanical sorting before the transparency is mounted.

Various attempts of course have been made to eliminate the use of adhesives and to remedy the defects mentioned, but none have been successful. Among such attempts, by way of example, is my prior Patent No. 2,587,022 in which heat bonding of thermoplastic materials to the card was suggested. For example, it was proposed to cover the aperture with a sheet of cellulose acetate and to bond its edges by heat and pressure to the edges of the card around the aperture. Since this cover sheet would be of the same material as the base of the film itself, it was thought that the film section and the cover sheet could be united integrally by heat to form a unitary transparency across the aperture. Usually heat damage resulted, such as clouding and/or buckling or warping of the film. Moreover, the bond formed by heating the cellulose acetate cover sheet in contact with the card, or the cellulose acetate base of the film itself as suggested in my Patent No. 2,633,655, was unsuccessful. If the degree of heat was only enough to soften the cellulose acetate it would not penetrate the fibers of the card and the bond was weak. Attempts to increase fluidity by raising the temperature usually caused warping or buckling of the card itself.

One of the objects of the present invention is to provide an improved aperture card system which not only eliminates adhesives but also provides a stronger and more permanent bond between the transparency and the card in which it is mounted.

Another object is to provide such an improved aperture card system which is simpler to use and requires substantially less elaborate and costly equipment, but which also remedies the defects of prior systems as outlined above and at the same time provides greater flexibility and adaptability in use.

More particularly, it is an object of the invention to provide an improved aperture card system utilizing a blank card which is both continuous in extent (i.e., not apertured) and uniform in thickness throughout its entire area, and is characterized by the complete absence of surface stickiness, being to all intents and purposes the same as the blank cards heretofore used in non-aperture card systems in which transparencies are not mounted in the cards.

Another object is to provide a novel aperture card as characterized in the preceding object, and further a blank card of this type in which there is no material deterioration over prolonged periods of storage, thereby facilitating the supply of blank cards in bulk quantities for use when needed, enabling the consecutive posting at intervals of film records and the like on the same card, etc.

A further object is the provision of a novel blank record card as characterized above, and a novel quick, easy and inexpensive procedure for making it, whereby thermoplastic bonding material is impregnated into and beneath the surface of the fibrous card material at desired points and carried permanently thereby ready for use when needed, without material change in the exterior of the card.

It is still another object of the present invention to provide an improved aperture card system utilizing an improved method of mounting transparencies in the blank aperture cards as characterized in the preceding objects, which method is relatively simple to practice and requires the use only of simple inexpensive equipment within the reach of any substantial user of the system, so that with a reserve supply of blank cards, transparencies can be mounted as and when desired and if desired only a few at a time by the user or customer himself.

Further objects thus are to eliminate the need for relying on service centers of the type described above, and to enable the transparencies to be prepared and mounted on the spot by the user who is familiar both with the transparencies and their significance and with the conditions of use of the mounted transparencies.

Another object is to provide an improved method as characterized in the preceding objects which produces a stronger and more permanent bond between the transparency and the card.

Yet another object is to produce a thermally activated fusion or bond between the impregnating material and the material of the transparency itself, and at the same time to control the heating operation so as to avoid damage to the portion of the transparency that is to be projected.

Still further objects include the provision of an improved aperture card system in which the transparency is mounted in the card without the use of adhesives that are likely to cause sticking; in which the transparency is mounted in the card without appreciably increasing the thickness of the card; in which the bond between the transparency and the card is not only much stronger than in prior systems, but substantially as strong and practically as durable as the card itself; and in which the thermoplastic material of the edges of the transparency itself is fused integrally with a like or a comparable material impregnated into the card so as to form a substantially homogeneous body of material integral with the transparency around its edges in which the card fibers at the edges of the apertures are embedded.

Generally speaking, the card may be of any suitable size and shape according to the use to which it is to be put, and it may be desired to mount one or a plurality of transparencies at selected locations. The first operation in the present invention is to impregnate the card material or at least the surface layer thereof where the film is to be bonded thereto, with a thermoplastic material capable of uniting or fusing with the material of the transparency itself when both are heated sufficiently to become soft and flowable under light pressure. The impregnating material should be dry and non-sticky or non-tacky at ordinary temperatures, say up to 200° F. or higher for example, and hence the use of temperatures high enough to liquify such materials involves the risk of damage to the card, while on the other hand the material even when melted lacks the fluidity required to penetrate the fibers. Impregnation is accomplished by dissolving the impregnating material in a solvent at or near room temperature. In most modern films, the use of cellulose nitrate as a film base has been abandoned in favor of cellulose acetate, and hence the impregnating material is usually required to be compatible, i.e., fusible, with the cellulose acetate forming the film base. Cellulose acetate itself is the preferred impregnating material in most cases. It can be dissolved, for example, in known solvents such as ethyl acetate, cyclohexanol, nitropropane, ethylene dichloride, and preferably in the readily available and widely used dimethyl ketone or acetone.

The depth to which the card will be impregnated beneath its surface will depend on factors such as the porosity of the fibrous material of the car ditself, the viscosity and surface tension of the solution, capillarity, and of course on the amount of solution applied, and can be controlled accordingly. However, it has been found that only the surface layer need be impregnated in order to insure a good bond, since the strength of the bond appears to depend on uniting or fusing the material of the film itself with preimpregnated material in which the surface fibers of the card are embedded or secured. It may be desirable to color the solution, in which case after the solvent dries out, the zone of impregnation will remain colored.

The zone of application of the solution must be such that the impregnating material will be located around the edges of the aperture, when it is eventually cut out. Of course, this can be accomplished by applying solution over the entire area of the aperture, but it is more economical and just as effective to distribute the solution in a strip pattern following the outline of the aperture. If a plurality of apertures are contemplated, there will be a plurality of such outlines to be followed. They may be marked on the cards or not, but at least their locations will be predetermined and known. The solution can be applied in the desired strip pattern or patterns by hand by simply brushing it on the surface of the card, but usually suitable mechanical applicator means will be preferred. For example, the cards may be moved in succession through a zone of application in which the desired strip pattern application is effected by relative movement between the individual cards and suitable applicators. A reciprocable stamping device with a suitable inker can be used, or the cards may be fed in succession through rotary printing devices; in either case the solution, colored or not, provides the "ink" with which the card is printed in the desired pattern.

So printed and then allowed to dry, the cards are ready for sale in bulk as blank cards. Except where they are preferably colored in printing, they are outwardly exactly the same as the original cards, without stickiness, without increase in thickness, and still of their original strength, but with cellulose acetate impregnated into the fibrous material beneath the card surface. Here it remains unchanged and without deterioration for as long as may be desired until the aperture or apertures are eventually cut; or in case a particular aperture is not cut out, as when a second aperture outline is provided for "posting" but not used, the impregnating material simply remains in the card without in any way detracting from its intended use.

When it comes to mounting a transparency in a blank card of the above type, the transparency is prepared in any suitable way. For example, it may require edge trimming to provide the desired size and shape, which obviously can be done by hand if desired. In cutting out transparencies from a roll of film or the like, however, suitable die-cutting apparatus, either hand or power operated, will usually be preferred.

The same type of die-cutting operation is preferred for cutting out the apertures in the cards. With the aid of suitable registering means, the cards can be fed one by one to a die in position such that operation of the die cuts the aperture with its edges lying in the strip pattern of impregnant. Any desired type of feeding mechanism can be used, or the cards can be fed by hand. For most purposes a simple reciprocating die is satisfactory; it can be operated by hand or foot, or by power means. The male die part may fit rather loosely in the female die part so that the cut edges of the aperture tend to be somewhat ragged rather than smooth, as this effect sometimes appears to improve the bonding action.

For bonding, the transparency is placed over the aperture with its edges overlapping the margins of the card around the aperture by a small amount, say $\frac{1}{32}$nd to $\frac{1}{16}$th of an inch. In the case of photographic film, the base side of the transparency, as distinguished from the side coated with the light-sensitive emulsion, is placed next to the card, usually on the back side of the card although it can be on the front side if desired. For convenience, the transparency is usually laid on the top of the card, whichever side thereof may be upward. Bonding is then accomplished by a combination of heat and pressure, the zone of pressure application being restricted substantially to the overlapping areas of the transparency and card. Where resistance heating is employed, the heating means are so arranged, as by means of heat-conductive distributing plates, for example, that heat is restricted substantially to the marginal overlapping portions of the card and film. Electrical heating means such as coiled Nichrome wires may underlie the heat distributing plates and may be connected with suitable energizing circuits capable of producing flash heating for short periods, usually only a few seconds.

Although good results have been obtained by resistance heating, it has been found more advantageous to use dielectric heating, especially in the case of machine sorting where any degree of warping or buckling of the card is objectionable. It will be understood that with the right frequency, it may be possible to heat only the cellulose acetate impregnated into the card and on the film, without materially increasing the temperature of the card fibers, and to attain a much higher temperature of the cellulose acetate in a much shorter time. The conditions are not critical, however. For example, using a 3,000 watt oscillator at a frequency of 27 megacycles, one or two seconds of heating were sufficient to produce a good bond without damaging the card, even when only about half of the available power was used.

Assuming the use of cellulose acetate solution for impregnation of the card and a photographic film having a cellulose acetate base, the bonding action appears to be explainable as follows, although it will be understood that the exact effects are microscopic in detail and somewhat obscure. It appears that the cellulose acetate solution soaks into the card to the desired depth, and that when the solvent evaporates, which takes place rapidly, the residual cellulose acetate is distributed through the impregnated zone of the card, presumably being deposited on the individual fibers of the cardboard and at least partially filling the voids between these fibers. When heat is applied as described above, the impregnated cellulose acetate and the cellulose acetate base of the film soften and become semiliquid and thermoplastic to an extent depending on the temperature attained. This may take place at temperatures in the range of 60° C.–100° C., although the melting point is much higher. With the concomitant application of pressure, the softened cellulose base of the film merges with the likewise softened cellulose acetate impregnated into the card and the total quantity of cellulose acetate hardens into a homogeneous integral body with the cardboard fibers embedded therein upon cooling. Excess softened cellulose acetate tends to squeeze out beyond the edge of the film section, or in around the edges of the aperture, with consequent thinning of the overlapping marginal portions of the film. At the same time there is a reduction in thickness of the marginal portions of the card itself due to the applied pressure and heat, with the result that upon cooling, the combined thickness of the overlapping edges or margins of the card around the aperture and edges or margins of the film is not materially greater than the original thickness of the card itself. The major portion of the area of the transparency, i.e., all of it except the narrow marginal strips, retains its original thickness and is depressed into the aperture, the increase in thickness forming a sort of shoulder which abuts the edge of the card aperture. In some cases, as when the card has been deeply impregnated and the softened cellulose acetate of the film base is squeezed in between the abutting shoulder of the film and edge of the aperture, additional bonding may take place, but this is not necessary to produce a satisfactory product.

It will be understood that the entire bonding action takes only a few seconds, at the most, and that the thermoplastic material cools and sets very rapidly, so that the entire operation of mounting the transparency in the card with a strong permanent bond is very quickly and simply accomplished. In large part, the effectiveness of the bonding action appears clearly to be due to the presence in the fibers of the card around the aperture of the impregnating body of the cellulose acetate. Without it a similar procedure produces only surface adhesion between the film and the card and the bond is unsatisfactory for practical purposes. Increasing the amount of heating in an effort to produce greater fluidity and perhaps better bonding merely results in heat damage to the card and/or the film as already described.

One embodiment of the invention has been illustrated in the accompanying drawings and described with particularlity in the following description, but it is to be understood that the invention is not restricted to this embodiment but is capable of various mechanical and physical forms, so that the drawings are not to be construed as a definition of the invention, reference being had to the appended claims for this purpose.

In said drawings, FIG. 1 is a partial illustration of an apertured card of the well known IBM type, having a transparency such as a section of microfilm mounted in an aperture therein.

FIG. 2 illustrates a suitable blank card impregnated in strip pattern outlining two apertures for eventual mounting of two different transparencies, and also indicating in dot and dash lines possible variations in the size, number and location of apertures that might be desired under different conditions;

FIG. 3 illustrates diagrammatically a suitable method of applying the impregnating liquid to the cards;

FIG. 4 is a diagrammatic perspective view of a suitable type of applicator device to be used as shown in FIG. 3;

FIG. 5 is a section on the line 5—5 of FIG. 2, showing the impregnation of the card;

FIG. 6 illustrates diagrammatically the operation of die-cutting the aperture in the card;

FIG. 7 is a perspective view illustrating the operation of applying microfilm section to the aperture preparatory to bonding;

FIGS. 8 and 9 illustrate successive stages in the bonding operation, using resistance heating;

FIG. 10 is an enlarged detail sectional view showing the resulting bond; and

FIG. 11 shows diagrammatically the presently preferred method of making the card shown in FIG. 10 by dielectric heating or so-called electronic welding.

The card shown in FIG. 1 is a punch card of known type currently in use with machine sorting equipment and bears on its face vertical columns of numerals from zero to nine, the number of such columns being as many as 75–80. As will be understood by those skilled in this art, each numeral represents a location which can be punched according to a pre-arranged code so that the cards can thereafter be sorted mechanically by devices which sense the locations of the punched-out openings.

Located at any suitable point in the card **1** is an aperture **2** of any desired size and shape corresponding to the transparency to be mounted. The particular location of the aperture that is shown in FIG. 1 is for purposes of illustration only and has no significance, any desired location being selected according to the requirements of intended use of the card. Of course, the selected location must take into account the code punching requirements, since the area selected for the aperture can not be used for punching in the normal manner.

The transparency **3** covers the aperture **2** and is bonded to the edges of the aperture throughout an overlapping area of suitable extent, as indicated by the dotted line **4**. As already explained, the transparency may be of any desired type, and for purposes of the following description it is assumed by way of example to be a microfilm of an engineering drawing which can be projected by exposing the card **1** to a suitable source of light. Any desired number of prints of any desired size can also be made from the card before it is returned to storage.

FIG. 2 illustrates by way of example possible locations of two apertures which are outlined by the impregnated strip patterns **5** and **6** shown as stippled areas in the figure. The dotted lines **7** and **8** show the intended locations of the edges of the apertures that will eventually be cut when the time comes to mount microfilm sections or like transparencies in the manner shown in FIG. 1. As shown, the strip pattern **5** corresponds substantially to the location of the single aperture shown in FIG. 1, and thus represents a "blank" card as it would be manufactured and sold in quantity for the eventual preparation of a series of cards of the FIG. 1 type. As shown in FIG. 2, the strip pattern of impregnating material is applied preferably to back of the card, i.e., the side opposite

the face on which the numerals in FIG. 1 appear. Thus the film section, when eventually mounted, will be applied to the back of the card.

The second strip pattern **6** is shown to illustrate the possibility of mounting more than one film section in a single card, whenever desired. It will be understood from the foregoing description that it is not necessary to mount both cards simultaneously. For example, it may be desired to cut out the aperture along the dotted line **7** and mount one film section in this aperture as shown in FIG. 1, leaving the card intact at the location of the strip pattern **6** until some indefinite future time when it may become desirable to cut out the second aperture along the line **8**. The series of dotted rectangles **9** illustrate other possible variations of the location, size and shape of apertures.

Referring now to FIG. 3, it is desirable for most purposes, and especially for large quantity production, to apply the impregnating material in the desired strip pattern **7** and/or **8** by mechanical means. FIG. 3 shows diagrammatically a type of equipment that can be used for this purpose. As indicated in this figure, blank cards **1** are fed lengthwise in succession by means of a suitable conveyor **10** driven by a roll **11** and pass into the throat formed between a backing roll **12** and an applicator roll **13** which are rotated simultaneously in the directions shown by the arrows. As a card passes between the rolls **12**, **13**, it is "linked" by means of applicators **14** according to the desired pattern, these applicators being of wick-type material and being supplied with impregnating solution by means of a transfer roll **15** rotating in a bath **16** of the solution. The "printed" cards pass between the rolls **12**, **13** to a discharge conveyor **17** similar to the conveyor **10**, **11**.

FIG. 4 shows more clearly, although still diagrammatically, a suitable arrangement of the applicators **14** on the roll **13** for making strip patterns of the type shown in FIG. 2. As shown, the circumferential bands at the ends of roll **13** will apply the horizontal strips of the rectangular stippled patterns **5** and **6** of FIG. 2 while the axial strips **18** will apply the vertical strips. It will be evident that by such means, "blank" cards such as illustrated in FIG. 2 can be produced very rapidly and in large quantities at low cost.

FIG. 5 is a section taken on the line 5—5 of FIG. 2 for the purpose of illustrating the effect of the "printing" operation shown in FIG. 3. The stippled area **19** of FIG. 5 shows the impregnation of the card **1** to a suitable depth by the solution from the bath **16**, the solvent evaporating rapidly after impregnation and depositing the desired impregnant such as cellulose acetate in the fibers of the card. The dotted line **20** in FIG. 5 corresponds to the dotted line **7** in FIG. 2, these lines being shown in both cases merely to illustrate where the cut will eventually be made to form the aperture.

The operation of cutting out the aperture can be performed by hand as already stated, but ordinarily will be performed by means of a suitable cutting or punching die as illustrated diagrammatically in FIG. 6. In this case the card **1** is shown lying on a bed plate **21** in which the die opening **22** is formed. The die member **23** has its end **24** suitable shaped to co-operate with the die opening **22** and to cut out a section of the card **1** predetermined along lines such as the dotted line **7** of FIG. 2, thus forming the desired aperture. In some cases it may be desired to provide a loose fit of the die member **24** in the die opening **22**, as indicated by the location of the arrows **25**, with the result that the edges of the aperture will be torn somewhat roughly rather than cut smoothly and evenly. In some cases such rough edges appear to improve the bonding action, but they are not necessary to obtain a bond that is fully satisfactory for most purposes.

FIGS. 7, 8 and 9 illustrate the subsequent operation of mounting a transparency in the aperture cut out by the die mechanism of FIG. 6. By way of example, a section of microfilm has been illustrated in these figures, this film comprising the usual base **26** of cellulose acetate coated on one side by a light-sensitive emulsion **27**. The film section is placed against the back of the card with the base **26** next to the card and the emulsion coating **27** facing outwardly. The cellulose acetate base **26** overlapping the impregnated edges **19** of the aperture. The extent of the overlap can vary as desired. For most purposes, using cellulose acetate as an impregnant and microfilm as a transparency, an overlap from 1/32" to 1/16" is sufficient to provide a satisfactory bond, but more overlap can be used if desired.

With the card and film in the relative positions shown in FIG. 7, the bonding operation can be performed as shown in FIGS. 8 and 9 by means of pressure applied by a suitable ram **28** and heat supplied simultaneously by a suitable metallic distributing plate **29** and heating coils **30**. As shown in FIG. 8, the area of application of pressure by the ram head **28** is sufficient to cover the area of overlap of the film and card at the edges of the aperture. The application of heat is also restricted substantially to this area by means of the distributing plate **29**, the size and shape of which corresponds substantially with the ram head.

FIG. 9 shows the bonding operation in which the ram head has been lowered to apply pressure to and to squeeze together the card and film over their overlapping areas, while simultaneously applying heat to these areas by means of the coils **30**. The temperature to which the base material of the film and the impregnant in the card are heated should be restricted to the point at which these materials become sufficiently soft and plastic to merge or fuse together under the applied pressure, since further heating to a point at which they might be more fluid would involve the risk of damaging the film and the card as already explained above. Using Nichrome coils **30** and a pressure of the order of several hundred pounds (i.e. total pressure on the ram **28**), it has been found that the desired temperature can readily be attained in a brief period of the order of 5–10 seconds of energization of the heating coils. In the case of cellulose acetate, for example, the softening point varies from about 60°–97° C. whereas the actual melting point is about 260° C. Such higher temperatures are unnecessary since the softening of the cellulose acetate, together with the application of pressure produces the desired result as explained below.

Referring to FIG. 10, the edges of the card **1** surrounding the aperture are depressed somewhat by the pressure applied through the ram **28**, together with the heating effects, as indicated at **31**. By way of example, a card **1** of the type illustrated in FIG. 1 may have an initial thickness of the order of 0.007 inch and may be compressed at the edge of the aperture to a thickness of the order of 0.005 to 0.006 inch depending upon the amount of heat utilized and the amount of pressure applied. On the other hand, the microfilm **26**, **27** may have an initial thickness of the order of 0.0055 inch, a major portion of which is the cellulose acetate base **26**. Under the effect of heat, the base **26** softens and becomes thermoplastic so that the pressure not only compresses the edge of the card as already explained, but also tends to squeeze at least part of the softened base material of the film itself out of the joint between the overlapping surfaces of the film and the card. Thus the actual thickness of the overlapping edge portion **32** of the film is also reduced substantially as indicated in FIG. 10, since a substantial part of the cellulose acetate base has been squeezed out laterally as indicated at **33**, or inwardly around the edges of the aperture at **34**. The combined thickness of the compressed edge of the card and the overlapping edge **32** of the film is not materially greater than the original thickness of the card **1** alone. This is possible because the major thickness of the film section throughout the area of the aperture is depressed into the aperture as shown in FIG. 10, leaving a substantially flush upper surface.

The bonding action results from the fact that the softened cellulose acetate from the film base **26** and the softened cellulose acetate of the impregnated zone **19** in the card are squeezed together under pressure and merge or coalesce into a homogeneous integral mass of material in which at least the surface fibers of the card are embedded. It is not necessary to force the softened base material of the film into the card fibers so as to effect impregnation. This would be difficult if not impossible to achieve because of the dense compact texture of the card itself, especially since the base material of the film cannot be heated to a high temperature so as to obtain greater fluidity without the risk of serious heat damage to the card and/or the film. Since zone **19** is already impregnated with cellulose acetate, however, it is only necessary to bring the contacting masses of cellulose acetate to a sufficiently softened state that they will coalesce under moderate pressure in order to obtain the desired bond.

It will be seen that the thickened portion of the film section abuts the edge of the aperture along the line **34** of FIG. 10. Because of the way in which the film and card have been processed, there will ordinarily be a close abutment with a tight fit of the film section inside the aperture. It will be understood that in some cases, more complete impregnation of the card and/or somewhat greater degree of squeezing-out action of the applied pressure may cause additional bonding to take place between the abutting faces **34** of the film base **26** and of the card aperture, but for most purposes this is not necessary.

While good results have been obtained by bonding as illustrated in FIGS. 8 and 9, it is preferable in many cases to use dielectric heating as is shown diagrammatically in FIG. 11 but not claimed per se herein. The card and film section in this figure occupy the same relative positions as shown in FIGS. 7, 8 and 9 described above and are interposed between a base electrode **35** and an upper electrode **36** connected by means of leads **37** to a suitable high frequency oscillator **38**. The dielectric heating effect is restricted to the overlapping edges of the card and film by forming an aperture in the upper electrode **36**, the edges **38** of which parallel the edges of the aperture in the card itself and by restricting the outer edges of said upper electrode to the desired amount of overlap. Preferably the aperture in the electrode **36** is filled with a suitable plastic material **40** to hold the film flat while the bonding action is taking place. Pressure is also applied, as indicated by the arrows **41**.

With such dielectric heating equipment, it is possible to concentrate the heating effect in the cellulose acetate itself, and to minimize heating of the card because of such concentration and also because of the fact that the time required to heat the cellulose acetate to the desired softening point is much less than even the few seconds required in the operation shown in FIGS. 8 and 9. By way of example, using a total pressure on the upper electrode **36** in the neighborhood of 400 pounds, and a 3,000 watt oscillator at about 27 megacycles and at roughly 50–75% of its available power, a period of 1–2 seconds proves sufficient to obtain bonding as described above in connection with FIG. 10. The finished card shows practically no increase in thickness and no warping or buckling, while the bond between the card and film is strong and permanent. The bonding operation can be performed at any time, regardless of the age of the "blank" impregnated card, and at no time either before or after mounting the transparency is there even a trace of adhesiveness or stickiness. These features of the invention result in the advantages set forth in detail above.

It will be understood that the invention is not restricted to the details of the foregoing description or of the drawings, which have been set forth only by way of example and can be varied by those skilled in the art without departing from the spirit of the invention. Reference should be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In record cards of fibrous material intended to be apertured subsequently at predetermined locations of areas of given size and shape suitable for mounting sections of microfilm and like projectable transparencies, a card having a continuous uninterrupted fibrous card structure throughout and surrounding one of said areas, a portion of said uninterrupted fibrous structure containing heat-sensitive potentially adhesive material impregnated therein and distributed between and around the fibers of said structure beneath one surface of said card, said impregnating material being non-sticky at normal temperature but heat-softenable to adhere to and hold the section to be mounted, said material being arranged in a pattern of strips surrounding and outlining the aperture subsequently to be formed in said card.

2. A record card as defined in claim 1, said impregnating material comprising cellulose acetate impregnating the fibrous material of the card throughout a major portion of its thickness from the side of the card on which said section is to be mounted, whereby said aperture is cut through and exposes said impregnated fibrous material.

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