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2,964,337

MANIFOLD FORMS AND PROCESSES OF MAKING THEM

Filed March 8, 1957

FIG. 1.

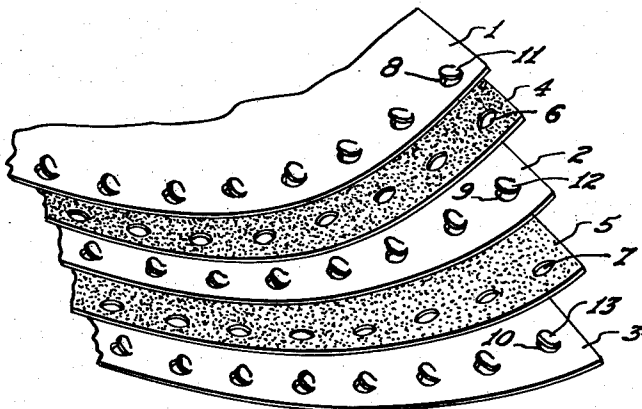


FIG. 2.

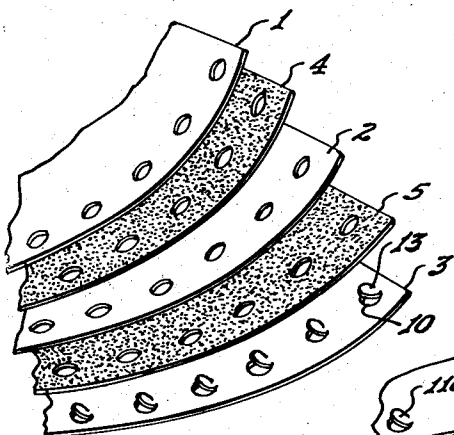


FIG. 3.

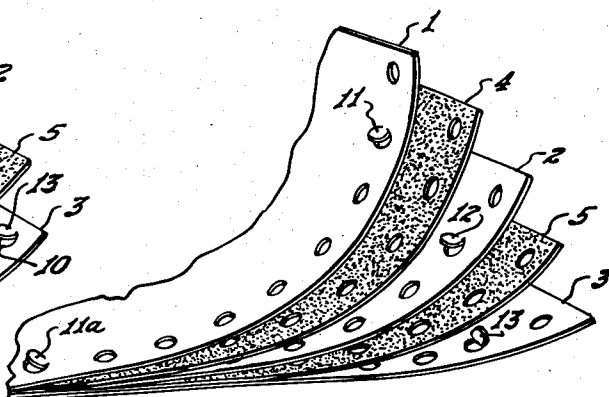


FIG. 5.

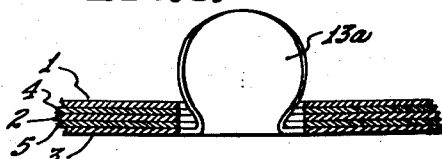
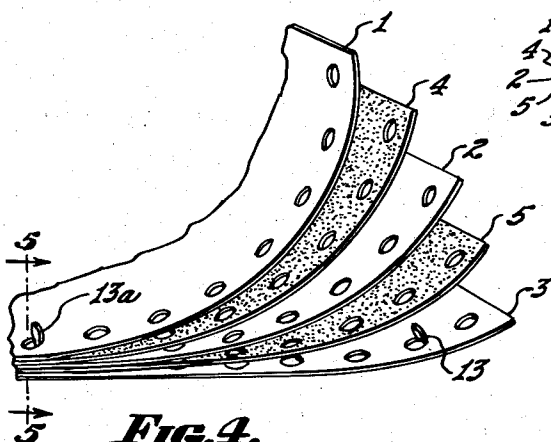


FIG. 4.



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1 Claim. (Cl. 282—21)

The invention relates to manifold forms in continuous strips, each form usually consisting of a top sheet or work sheet and one or more copy sheets with carbon sheets interleaved between the work sheet and the adjacent copy sheet, and between adjacent ones of the copy sheets if there are a plurality of them. Such manifold forms are provided with evenly spaced edge perforations so that they may be fed through the working space of typewriters or the like by pinwheel or other pin feeding devices which align the various sheets, all as is well known in the art.

In some such structures the carbon sheets are narrower than the other sheets so that their lateral edges lie between the rows or perforations. In others, the carbon sheets are coextensive width-wise with the other sheets and are provided with holes at the edges. The sheets making the manifold have transverse lines of weakening at intervals so that after the manifold has been worked upon, it may be severed into individual forms. In some structures provision is made such that when the manifold has been severed into individual group of forms, the carbon sheets will extend at one point beyond the other sheets (which likewise are free of the carbon sheets at another point) thus facilitating quick removal of the carbon sheets. With other manifold forms, various types of decollating machines are used to separate the carbon sheets from the other sheets, usually before the forms are separated into individual units.

It will be understood that manifold forms are usually folded backwardly and forwardly on the transverse lines of severance so as to produce a flat assembly from which the manifold form can nevertheless be fed continuously.

The problems involved in any type of use of marginally punched manifold forms of the type hereinabove set forth involve accurate printing, punching and perforating of the forms, the folding of the forms into packs, their use through machines, and their refolding characteristics. However, in the feeding of the forms, the carbon sheets have a tendency to creep in the direction of motion of the forms and sometimes laterally. An adequate solution for these difficulties was found, as hereinafter discussed, when the forms were fed by pin-wheel devices. However, many modern business machines operating at high speeds, and particularly high speed printers, tabulators and the like, make use of tractor type pin feeds. The use of these feeding devices at very high speeds has presented a new series of problems; and it is a primary object of this invention to provide manifold forms which may be perfectly fed at high speeds through the working spaces of modern business machines as well as over pin-wheel feeders.

The solution of these problems involves changes in the manufacture of the forms and particularly changes in the relationships of the individual form lengths in the sheets making up the manifold form assemblies, all as hereinafter set forth. But paper forms are affected by

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moisture and other conditions tending to alter their dimensions, and there is a limit to the specific accuracy attainable in the manufacture of the forms. The primary object of this invention is attained by a combination of relative dimensional characteristics in the individual forms making up the assembly, and a means for lightly holding the individual forms together primarily during the feeding operation. Consequently it is an object of the invention to provide a means for lightly holding the individual forms together during feeding, but in such a way that the forms thereafter may be readily separated.

Various means for holding individual forms together have hitherto been suggested in the art. If the various sheets were solidly cemented together, say at the edges beyond the perforations, this would interfere with the forming of a folded stack, since the individual sheets must slip slightly with respect to each other in the folding and unfolding. Moreover, if limited movement of the sheets were prevented, the aligning function of a pin feed would be lost. Prior art suggestions, such as fastening individual forms together with staples, stitching and interlocked tongues are likely to prevent all limited relative movement of the sheets and do prevent ready separation of the sheets as in decollating machines. Thus prior art fastening means are not suitable for the practice of this invention.

It is an object of the invention to provide a means for holding together the sheets in a manifold form which is not characterized by any of the above defects.

Specifically, it is an object of the invention to provide a means for fastening the sheets together which is inexpensive, in that it entails no additional cost in manufacture or in use.

It is an object of the invention to provide a means for the purpose described which will permit shifting of the individual sheets sufficient for folding and alignment purposes, but which will hold the sheets together adequately during the operation of high speed business machines.

It is an object of the invention to provide a means for the purpose described which will not interfere with the separation of the sheets by decollating machines.

It is an object of the invention to provide a fastening means which is self-reforming when the manifold form is fed.

It is an object of the invention to provide a means for the purpose described which will not interfere either with the original folding into a stack or with refolding after the forms have been operated upon.

It is an object of the invention to provide a means for the purpose described which will not appreciably bulk the forms or diminish the density of a stack thereof.

These and other objects of the invention which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, are accomplished by that particular arrangement of parts and in that procedure of which certain exemplary embodiments will now be described. Reference is made to the accompanying drawings wherein:

Figure 1 is an exploded perspective view of a portion of a manifold form illustrating one embodiment of the invention.

Figure 2 is a similar view showing another embodiment of the invention.

Figure 3 is a similar view showing yet another embodiment of the invention.

Figure 4 is a similar view showing a fourth embodiment of the invention.

Figure 5 is a sectional view taken along the section line 5—5 of Figure 4.

It has been pointed out above that there is a tendency for the carbon sheets in manifold forms to creep when

the forms are subjected to pin feeds. It has long been the practice to form the carbon sheets with perforations which are larger than the perforations in the working sheets and copy sheets. Thus if the perforations in the work and copy sheets are $\frac{1}{32}$ of an inch in diameter, the perforations in the carbon sheets may be $\frac{1}{32}$ of an inch in diameter. Such a practice will be followed in connection with the present invention; but it does not provide a cure for the creeping tendency of the carbon sheets. In the manufacture and use of marginally punched forms to be fed over pin-wheel feeding devices, it was found that, certain length relationship of the individual forms in the various sheets would mitigate or compensate for the tendency of the carbon sheets to creep. These are most easily expressed in terms of manufacturing tolerances. In an exemplary operation the workers in the press room and in the carbon department supplied with gauges which were exactly 88 inches long. The pressman being responsible for the printed work sheets and copy sheets was required to keep them within a tolerance expressed as "on the line to $\frac{1}{32}$ inch long." On the other hand the man in the carbon department, using the same type gauge, had to keep the carbon paper within a tolerance expressed as "on the line to $\frac{1}{32}$ inch under." When these tolerances were adhered to, it will be clear that the printed forms on the work and copy sheets would average slightly longer than the corresponding divisions of the carbon sheets.

The manufacture of the forms to these tolerances largely meet any feeding difficulty encountered with properly made pin-wheel feeding devices. As indicated, many business machines not only operate today at extraordinarily high speeds, but also make use of tractor type feeding devices in which a plurality of pins engage the marginal punched holes in a manifold form at any one time. In one such tractor feed six pins engage the marginal holes in the forms at each side, making a total of twelve pins in engagement with a form at one time. With such feeds feeding difficulties were encountered at the high speeds involved. It was found that the carbon sheets crept in the forward direction at such a rate that eventually the carbon sheets would close the marginal holes completely, causing the manifold form to jump the pins, and causing inaccuracy both in feeding and in refolding.

Various expedients were tried; it was found that if the carbon length were made still shorter in relation to the length of the work sheets and copy sheets, contrary to expectations the tendency became exaggerated.

It was found that if the work sheet and copy sheet forms were made to the tolerance set forth above, but the carbon forms held exactly "on the line" the creeping tendency somewhat diminished although creeping was still present. It will be appreciated that due to normal manufacturing inaccuracies it is not feasible to produce any of the form sheets to a precise length economically.

In another series of tests it was found that if the work and copy sheets were held to the "on the line to $\frac{1}{32}$ inch long tolerance," and the carbon sheets were held as closely as possible to a length expressed as " $\frac{1}{16}$ inch long" over the 88 inch gauge, the forms worked perfectly over the high speed tractor feed machines, but only so long as the above length relationships were actually maintained.

As pointed out above some slight inaccuracy is inherent in manufacturing operations. But paper webs have a tendency to expand and to shrink under varying conditions of temperature and moisture. The webs also have a tendency under pressure to stretch and then return in part at least to their original length.

When the various sheets are collated, it may happen that there is a difference in the moisture content of the work sheet and the copy sheets or a difference between the moisture content of these sheets and the carbon sheets. When the manifold form is packaged in a folded condi-

tion, the tendency toward moisture equalization may produce a variation of the moisture content of various sheets in the same or in opposite directions. Yet again if the folded forms are packed in new boxes of high moisture content all of the forms may pick up moisture therefrom and change their respective dimensions. Different types of paper expand or contract differentially with equal changes of moisture. For example with a given moisture change a variation of $\frac{1}{16}$ inch in an 88 inch length may take place while the same moisture change might produce a variation of $\frac{1}{25}$ inch in a paper made primarily of rag fibers. The lengths of the sheets not only vary but their widths as well with changing atmospheric conditions.

The moisture conditions during form manufacture may be lowered or maintained lower than those which are likely to obtain in a customer's office during the use of the forms. Thus it may be good practice to set the punching units a predetermined distance widthwise in the under-size direction. For example, on a form having a nominal width of $14\frac{3}{8}$ inches, the line of marginal perforations may be spaced from each other $\frac{1}{32}$ of an inch under the nominal width in view of the fact that by the time the customer is ready to use the forms they will have expanded to the proper size. Conversely if the forms are made under conditions of humidity likely to be higher than those of form use, the lines of perforations may be spaced oversize to compensate for this.

The manufacture of the forms to the tolerances set forth above plus the features of compensation last discussed, provide manifold forms which in many instances feed perfectly under the circumstances outlined, but which under unusual circumstances may give some degree of trouble. To increase still further the average over-length of the carbons does not eliminate the difficulty. It has been found, however, that if the forms additionally are lightly held together in the way hereinafter set forth, a commercially perfectly feeding form is attained. In effect, the light holding action compensates for those variations inevitable in manufacturing operations and those variations arise from expansion and contraction because of the conditions set forth above, to the extent that forms may be produced which can be reliably fed over pin feeding devices particularly of the tractor type, even at very high speeds and in spite of those conditions of variable pressures and the like which obtain in the work areas of high speed business machines.

The light attachment of the sheets may be readily effected by making the lateral perforations of at least an underlying sheet of paper in the manifold form in such fashion that as to some of the perforations at least, the material will not be severed throughout a complete circle but instead will form a captive tab which remains with the sheet. When the sheet is collated with overlying sheets in the usual fashion and by use of the usual collating machine having a pin feed, the pins of the feed will strike the tabs through the perforations of the overlying sheets, fastening the sheets together in a way which will permit sufficient shifting both for folding and for feeding purposes, while at the same time the sheets may be readily separated as in a decollating machine. It has been found that the tabs so formed do not interfere with the normal feeding of the manifold or with that realignment by jogging which is characteristic of the operation of normal pin feeds.

As is well known, the individual feed perforations along the marginal edges of forms are produced by the cooperative action of a punch and die. In order to produce the captive tab aforesaid, it is only necessary to file or flatten the punch at one side so that it will not sever the paper thereat. It is desirable to have the tab firmly attached to the sheet, while still capable of opening up the feeding hole nearly to its full extent. Thus it is preferable to leave the paper uncut for about $\frac{1}{8}$ of the circumference of the perforation, or from about $\frac{1}{4}$

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to $\frac{1}{8}$. It has been found further that best results are secured when the tab is hinged in the forward direction as respects the longitudinal axis of the manifold form, i.e. toward the head of the form. All tabs in any one sheet or layer should be hinged on the same side; and if captive tabs are formed in more than one layer of the manifold form, all such tabs should be hinged in the same direction.

In the manufacture of manifold forms, the work and copy sheets or strips of paper making up the manifold form are provided with evenly spaced edge perforations to coact with pin feeding devices. While this constitutes no limitation upon the invention, these perforations may be say $\frac{3}{32}$ inch in diameter and spaced $\frac{1}{2}$ inch on centers. The carbon sheets have larger holes, say $\frac{7}{32}$ inch. The work sheet and the copy sheets will normally be printed with form indicia and this indicia will be related to the spacing of the holes so that the manifold form may be accurately located in the working space of business machines for the insertion of data as by typewriting on lines or in spaces of the forms. The length of individual forms making up the manifold may be anything desired so long as it is commensurate with the spacing between the perforations.

In Figure 1 there is shown an exploded view of a portion of an exemplary manifold form comprising a work sheet 1 and copy sheets 2 and 3, with carbon sheets 4 and 5 interleaved between the work sheet and the first copy sheet, and between the first and second copy sheets. The number of sheets in the manifold form may be varied as desired. In the particular embodiment the carbon sheets 4 and 5 are provided with the relatively larger pin feeding edge perforations 6 and 7. The dies forming the relatively smaller edge perforations 8, 9 and 10 of sheets 1, 2 and 3 have, however, been flattened at one side to provide for each sheet a series of captive tabs 11, 12 or 13. When the various sheets of Figure 1 are run together and collated in a collating machine by means of a feed having pins entering the perforations, it will be clear that the pins will strike the captive tabs of perforations in lower sheets through the perforations of upper sheets wherein they will tend to engage frictionally, holding the sheets lightly together. The engagement is not tight, and the sheets are free to shift slightly with respect to each other as in folding or jogging because the round-edged tabs under sufficient stress can slip in the holes through which they are thrust. In most instances of normal shifting of the paper layers the tabs do not come entirely out of the holes in overlying sheets; but if there is enough shifting to disengage the tabs entirely from overlying sheets, it will be evident that the tabs are merely flattened down against the sheets from which they were struck. As a consequence, when the manifold form is again run over a pin feed, as when the form is withdrawn from a flat fold, the sheets will be realigned as to their holes and the interlock will be reformed by the pin action. Neither does the engagement of the tabs interfere with refolding the forms after they have been fed through a machine.

It is not necessary that the captive tabs be formed in the top or work sheet 1, if this sheet can conveniently be provided with edge perforations by means of a different set of dies from those employed on the other sheets. Excellent results are secured by forming the captive tabs only in the lowermost sheet or in two or more sheets beneath the top layer or layers of the form. This type of modification is illustrated in Figure 2 where the captive tabs 13 have been shown as formed only on the perforations 10 of the lowermost copy sheet 3.

The captive tabs may be formed on all of the perforations of at least the lowermost sheet of the manifold form, and in this event the sheets will be held together throughout the length of their side edges. But it is usually sufficient to form captive tabs only at intervals

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in any line of perforations whether the captive tabs be formed in all of the sheets making up the manifold, or only in a lower sheet or sheets. This is generally illustrated in Figure 3 wherein captive tabs are shown at 11, 12 and 13 and again at 11a at a point spaced a distance from the point 11. While tabs have been shown in sheets 1, 2 and 3 in Figure 3, the tabs may be omitted from any or all of the upper sheets of the manifold. Thus in Figure 4 there is shown a partially exploded manifold form in which the lower copy sheet has a captive tab at 13 and another at 13a, sheets 1 and 2 and the intervening carbon sheets 4 and 5 being free of tabs.

In an exemplary punching operation the paper strips are treated between a die roll and a punch roll, the punch roll having at each position for the formation of a line of perforations a series of twenty-two punches, the die roll having at the same positions an equivalent number of dies. To achieve the purposes of the invention, the number of punches in each series which will be treated to form captive tabs will preferably be selected in accordance with the length of the individual forms, so as to provide at least one interlock for each fold in a folded manifold form. In a series of twenty-two punches the provision of four special punches adapted to provide captive tabs will take care of a wide variety of form lengths, by way of example. These interlocks need not fall in the same relative position for each successive form, and it is an advantage of the invention that the interlocking action will be effected by the pins of the conventional pin feeding devices irrespective of where the captive tabs fall along the sides of individual forms.

The frictional engagement of the interlocks of this invention may be increased by the expedient illustrated in Figure 5. Here the overlying sheets of the manifold form, 1, 4, 2 and 5 have been provided with standard sized edge perforations. The lowermost sheet 3, wherein the captive tabs are formed either in immediate succession or at intervals as described above, is provided with slightly larger perforations, say perforations which are substantially .002 to .003 inch larger. This results in a tab 13 which is slightly oversize as respects the perforations in the overlying sheets and thus has a greater frictional engagement therein when the interlock is effected. It should be pointed out, however, that no great amount of frictional engagement is necessary to accomplish the purpose of this invention, since this purpose is not that of fastening individual forms together for subsequent use, but rather the control of the forms during high speed feeding operations. Various conditions, including the thickness and qualities of the paper, affect the exact nature of the frictional engagement; and while the frictional engagement should be enough to control the sheets during feeding, it should not be such as to prevent normal relative movement of the sheets, nor such as to interfere with the operation of decollating machines. A difference between the diameter of the tab and the diameter of the hole in which it is to engage is not usually either necessary or desirable. Further, the frictional engagement should not be such as to tend unduly toward the detachment of the tabs.

The treated forms of this invention, combining the length relationships and the aspects of frictional control, work very well on high speed business machines such as those set forth above. Beyond the treatment of certain punches to form the captive tabs, it costs no more to produce a manifold form in accordance with this invention than to produce ordinary forms which have no aspect of frictional control. These forms may be folded into packs which exhibit no significant bulk increase; they may be withdrawn from such packs, worked upon, and refolded. While the various sheets are frictionally controlled as respects each other, there is enough slippage between the sheets not only to permit the folding into packs but also to permit the accurate alignment of the

7 sheets by the action of pin feeds. Whether or not the carbon sheets are provided with edge perforations (with or without captive tabs) or whether the carbon sheets are so cut that their edges lie between the lines of perforation of the work and copy sheets, the carbons are prevented from working out the sides of manifold forms during the operation of high speed business machines. The nature of the frictional engagement is such that there is little tendency for the captive tabs to become detached from the sheets in which they were formed, and no tendency has been encountered for the sheets to become torn as a result of the action of the tabs. The forms of this invention present no greater problem of "confetti" disposal than do prior forms made under good manufacturing conditions.

Modifications may be made in the invention without departing from the spirit of it. The invention having been described in certain exemplary embodiments, what is claimed as new and desired to be secured by Letters Patent is:

A manifold fanfolded form for high-speed pin feeding by means of tractor pin feed devices said form comprising a plurality of strips in overlying relationship, each of said strips being divided by transverse lines of weakening into a plurality of individual forms, said strips being folded together along said transverse lines of weakening backwardly and forwardly to provide a fan-folded stack, said strips comprising a top work strip of paper and at least one copy strip of paper with a carbon strip interleaved between, the said work strip, copy strips, and carbon

bon strips having edge perforations for pin feeding, the individual forms in said work strip and copy strip having a length in the direction of the length of said manifold form which is slightly shorter than the length of the individual forms in said carbon strip by an average amount of about $\frac{1}{64}$ inch in a length of 88 inches, said edge perforations having the form of generally circular openings in the marginal portions of said strips, certain at least of the edge perforations in the last said copy strip being characterized by an incompletely circular cut whereby a captive tab is produced, hinged to the strip in the direction of the length of said strip, whereby said tab may be thrust through the perforation of said work strip by the pin of a pin feed to fasten said strips together detachably and under light engagement which will not interfere with longitudinal movement of said strips as respects each other, there being at least one of said tabs for each individual form in said manifold form.

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