

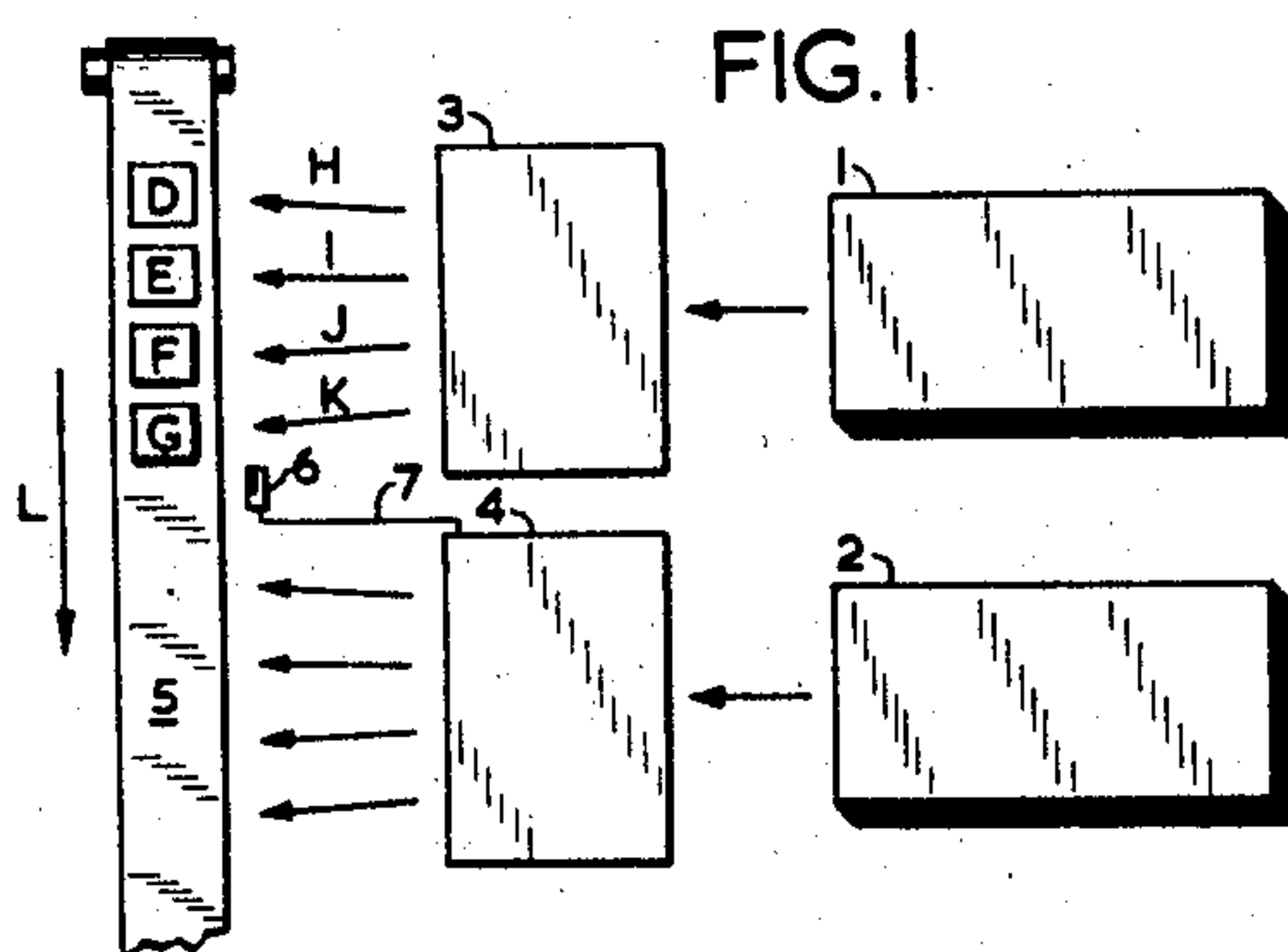
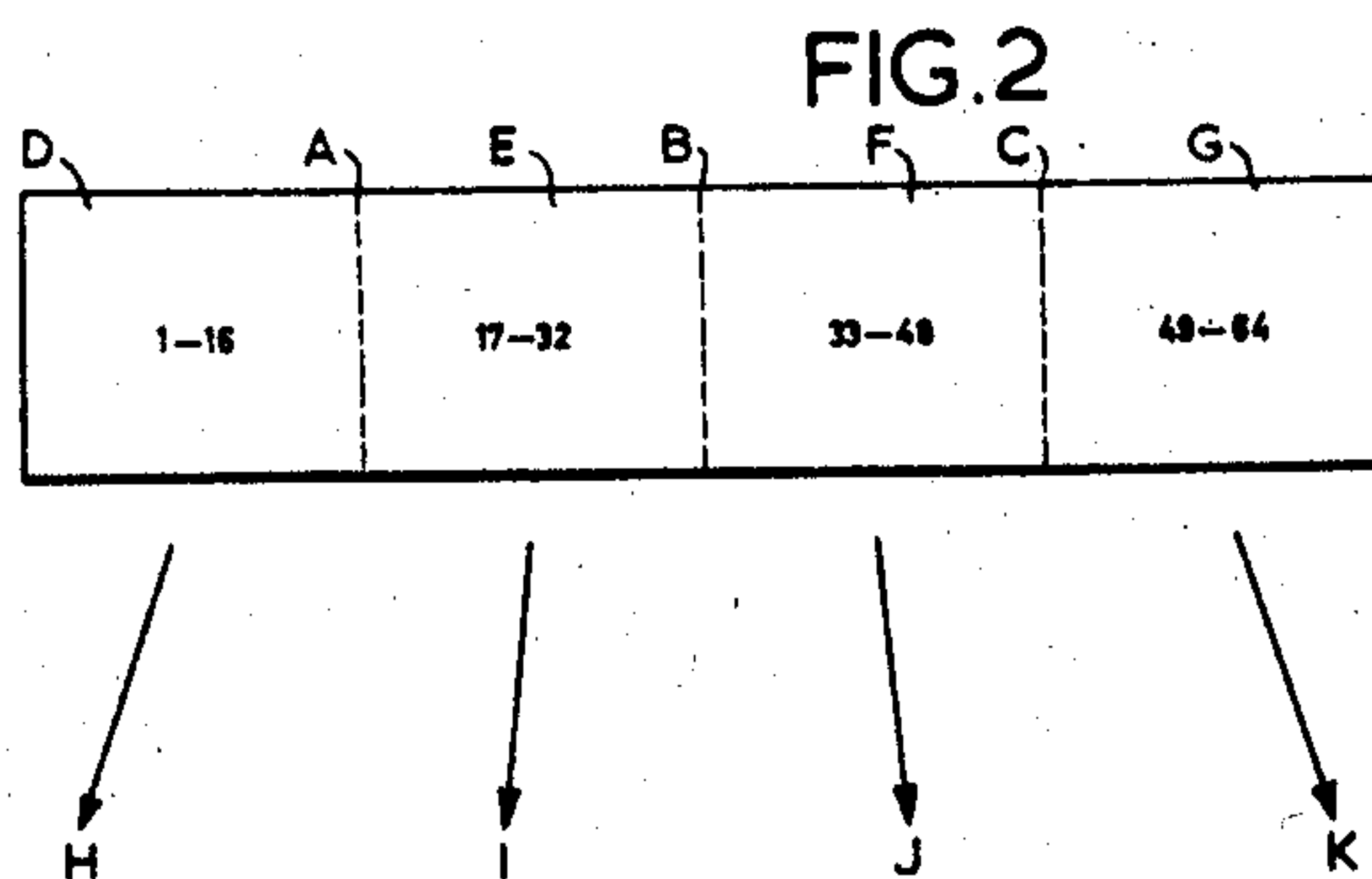
April 29, 1969

J. V. CARSTENS
METHOD OF DELIVERING SUPERIMPOSED FOLDED SHEETS
AS PREPARED BOOKS

3,441,267

Original Filed Jan. 28, 1963

Sheet 1 of 4



INVENTOR

Jorgen V. Carstens

BY

Stevens, Davis, Miller & Mosher
ATTORNEYS

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FIG. 3

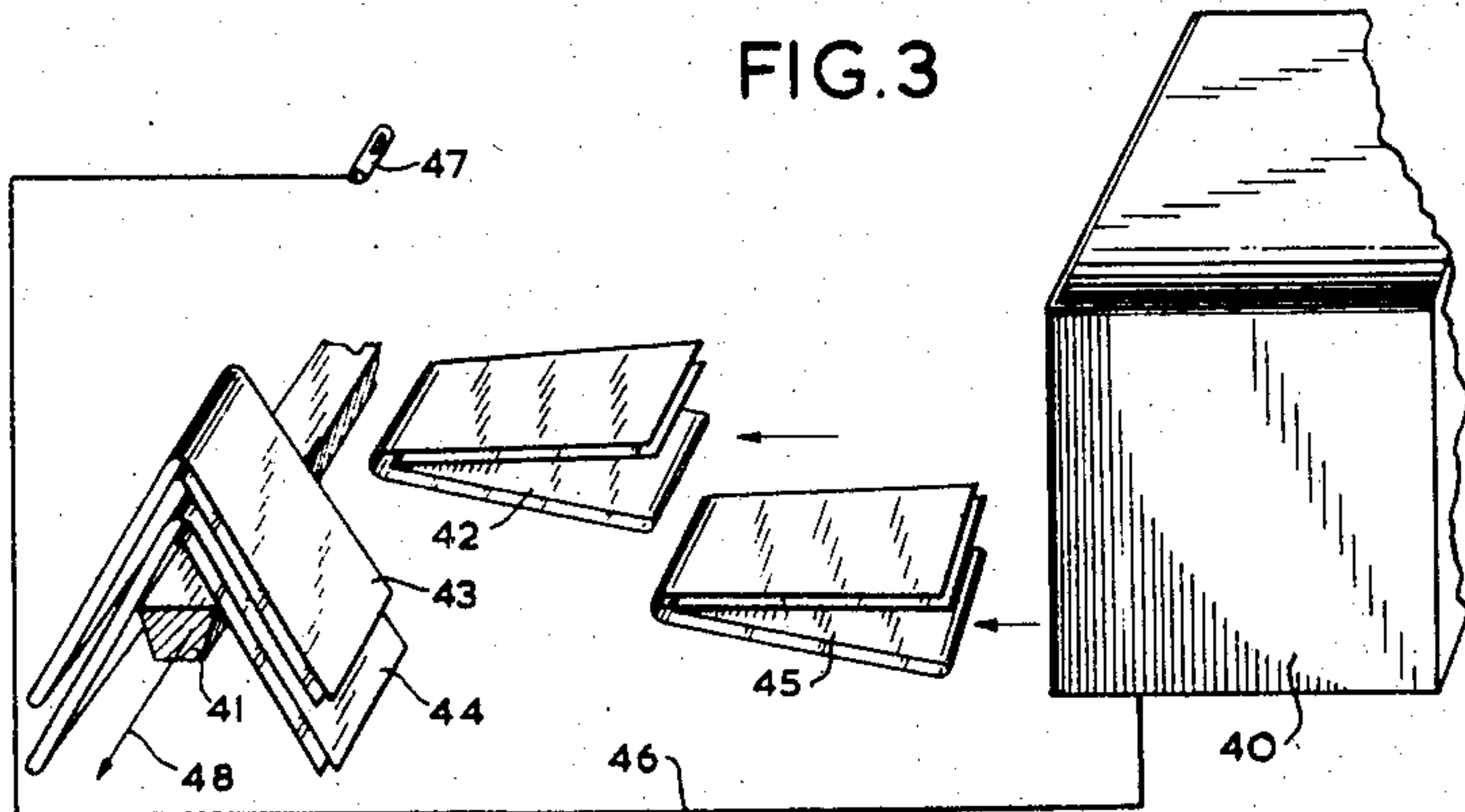


FIG. 4

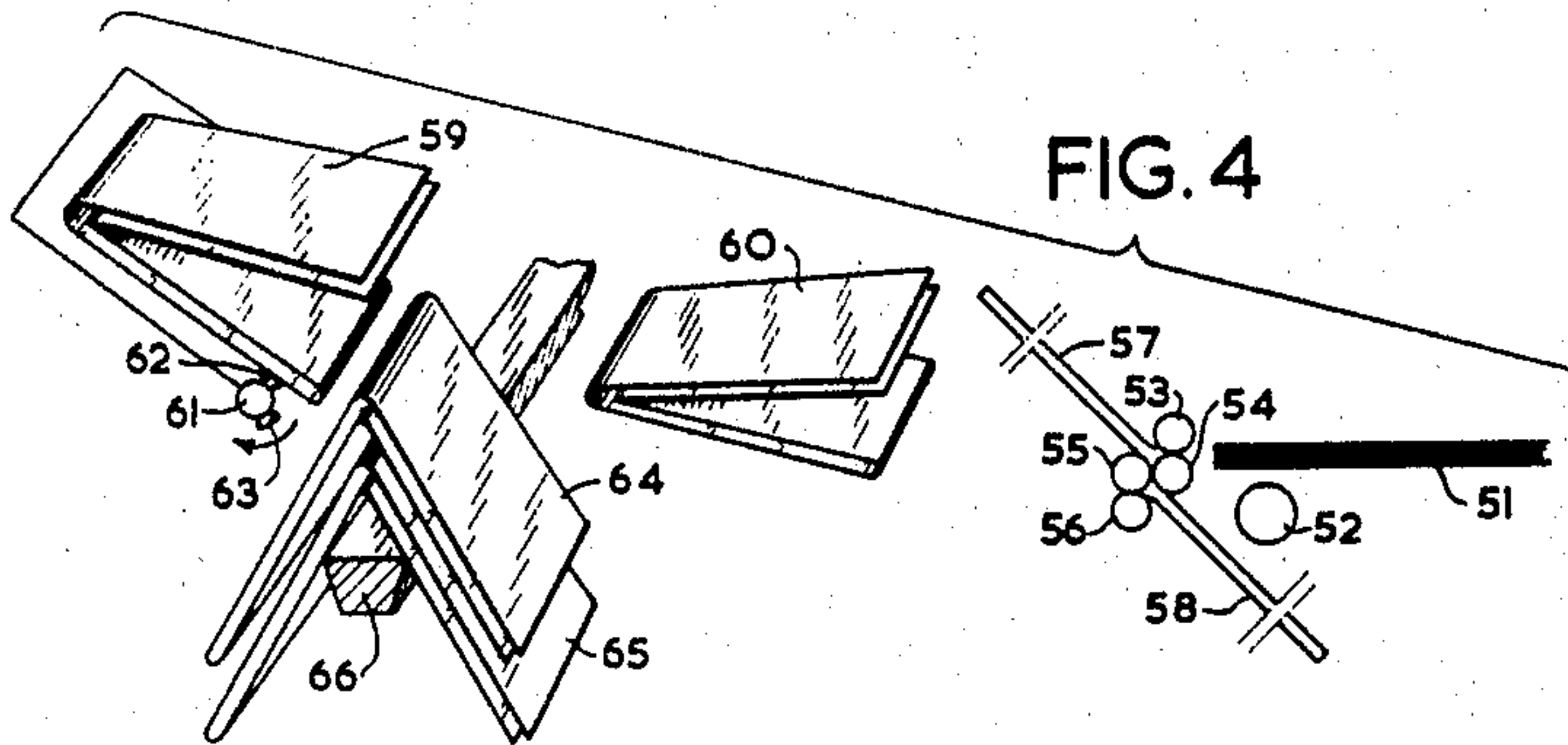
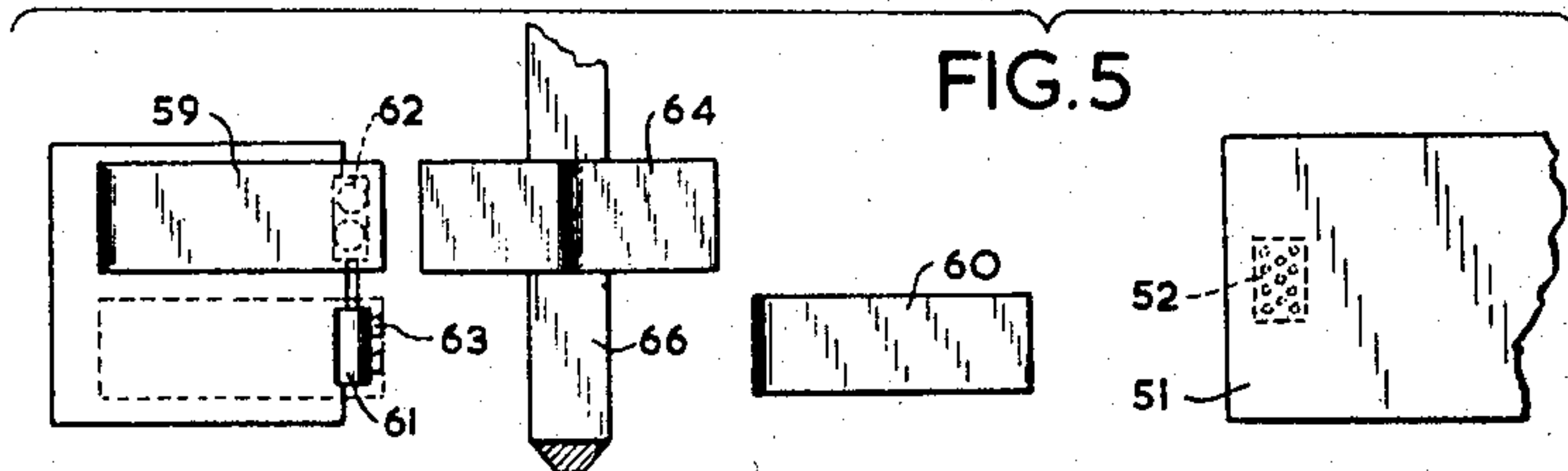


FIG. 5



INVENTOR

Jorgen V. Carstens

BY

Stevens, Davis, Miller & Mosher
ATTORNEYS

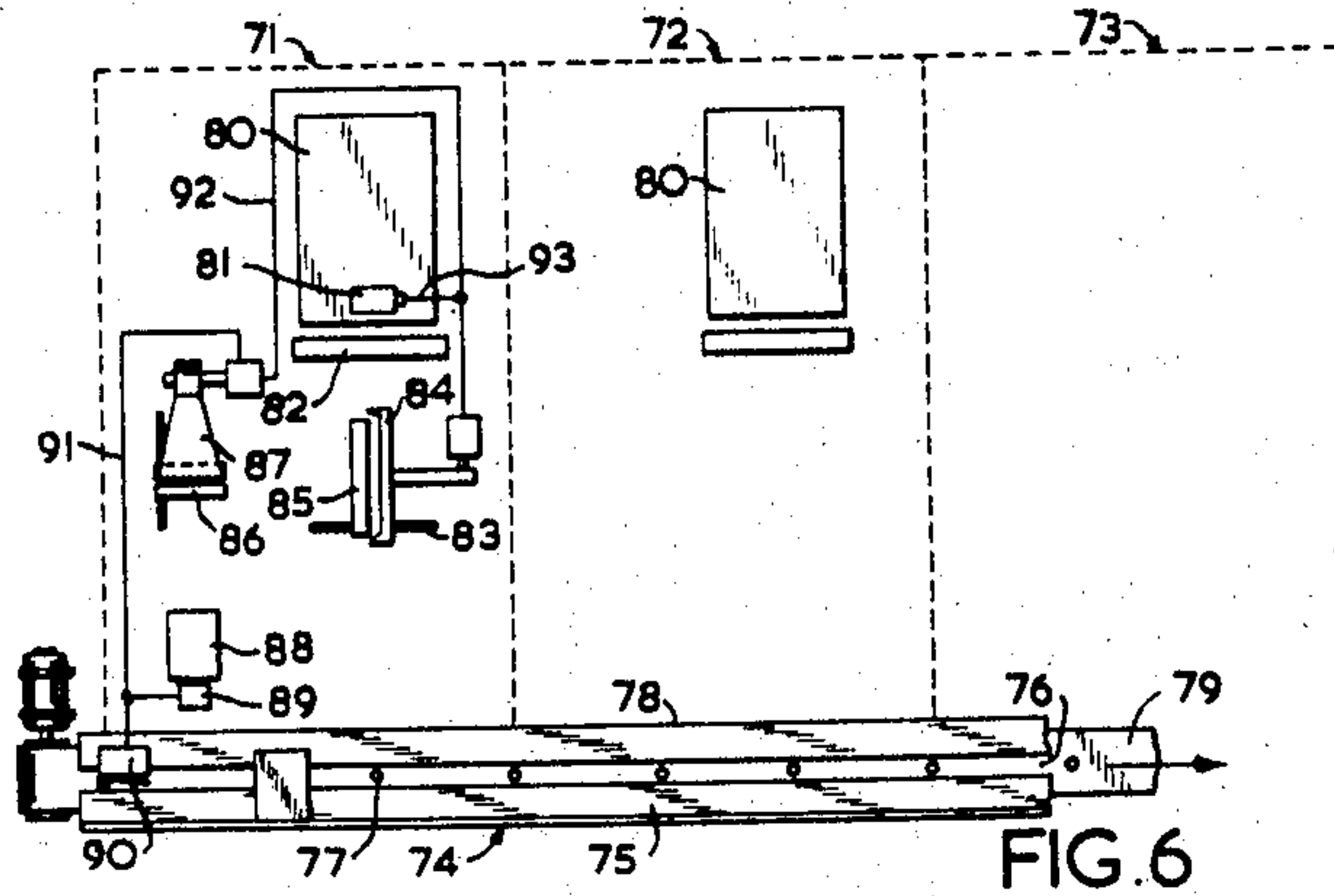
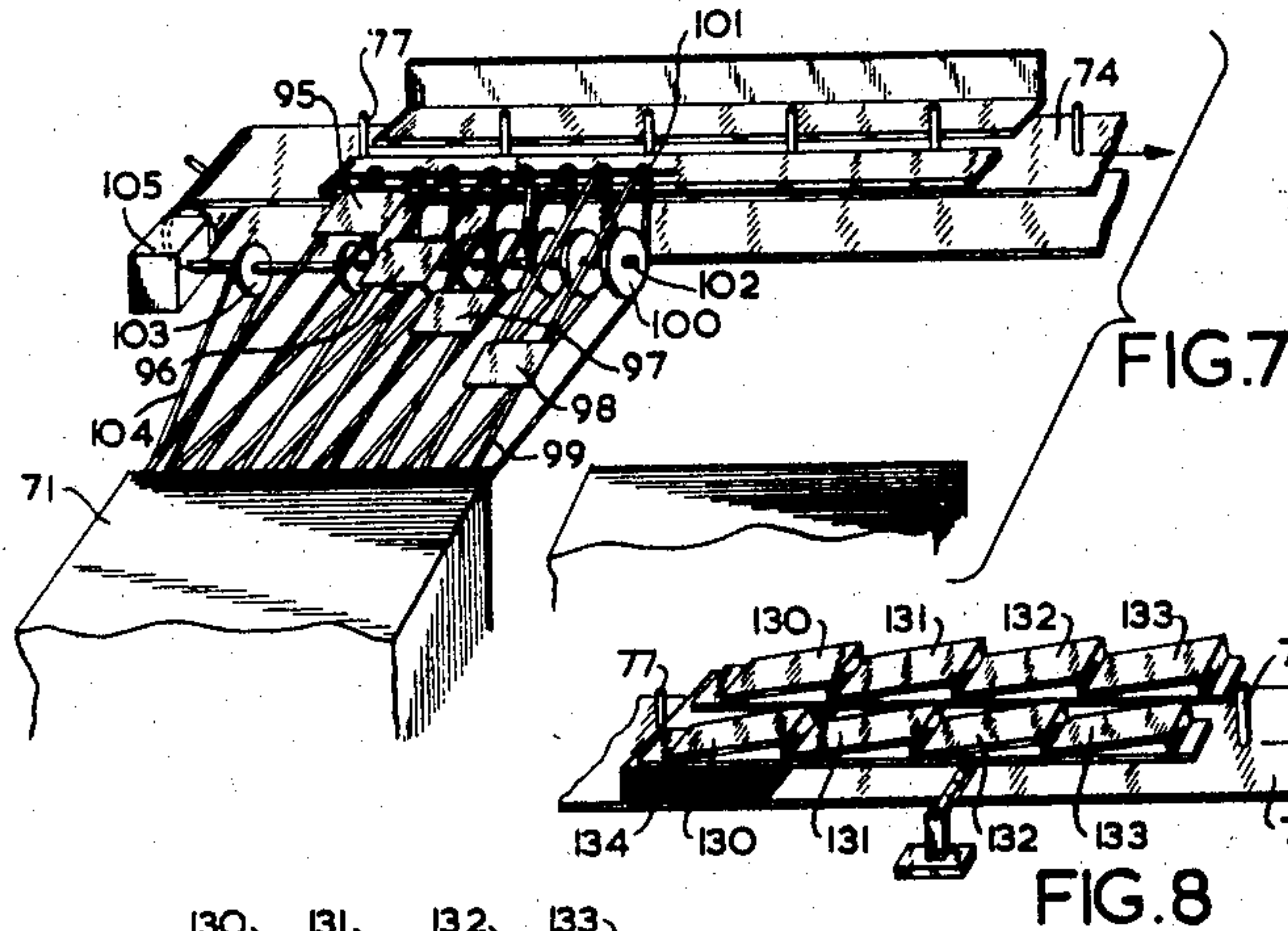
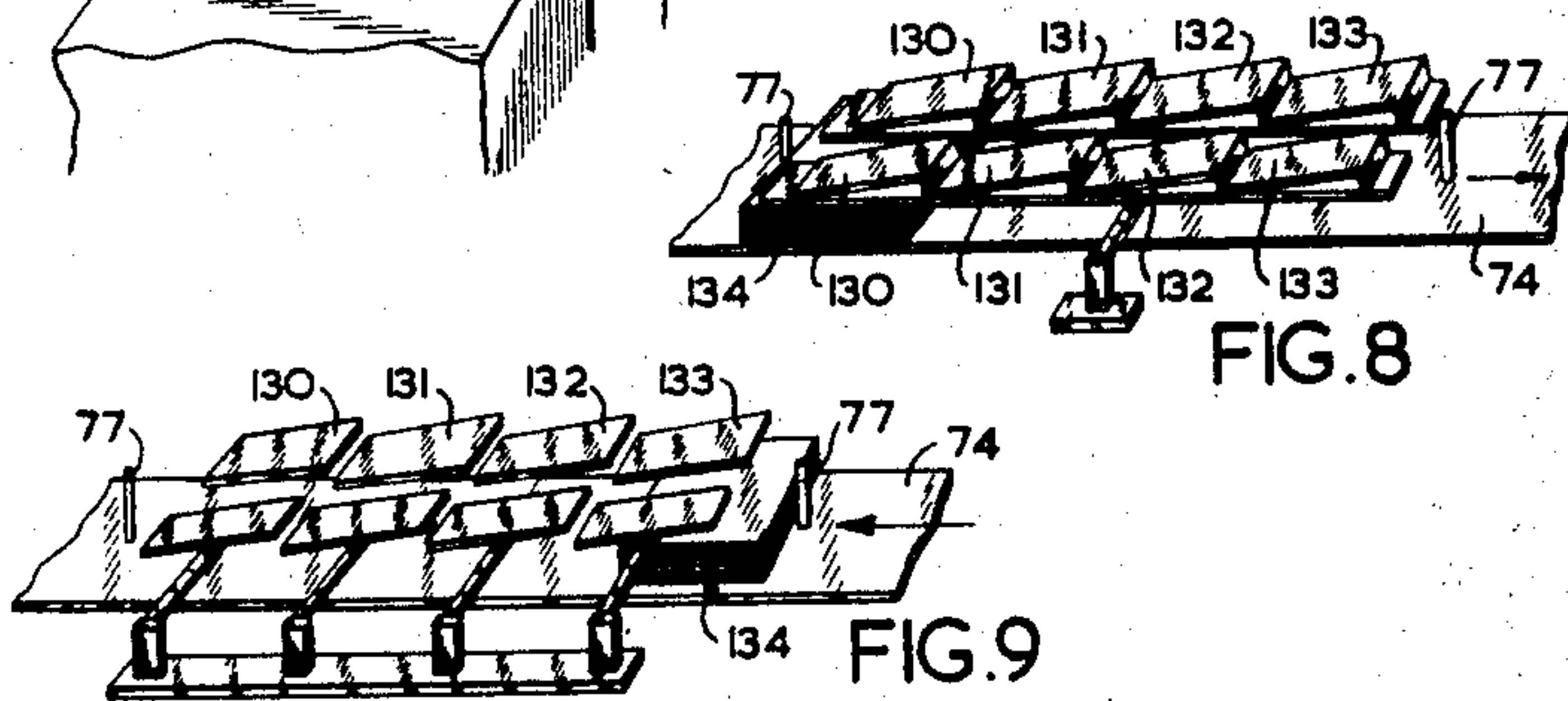
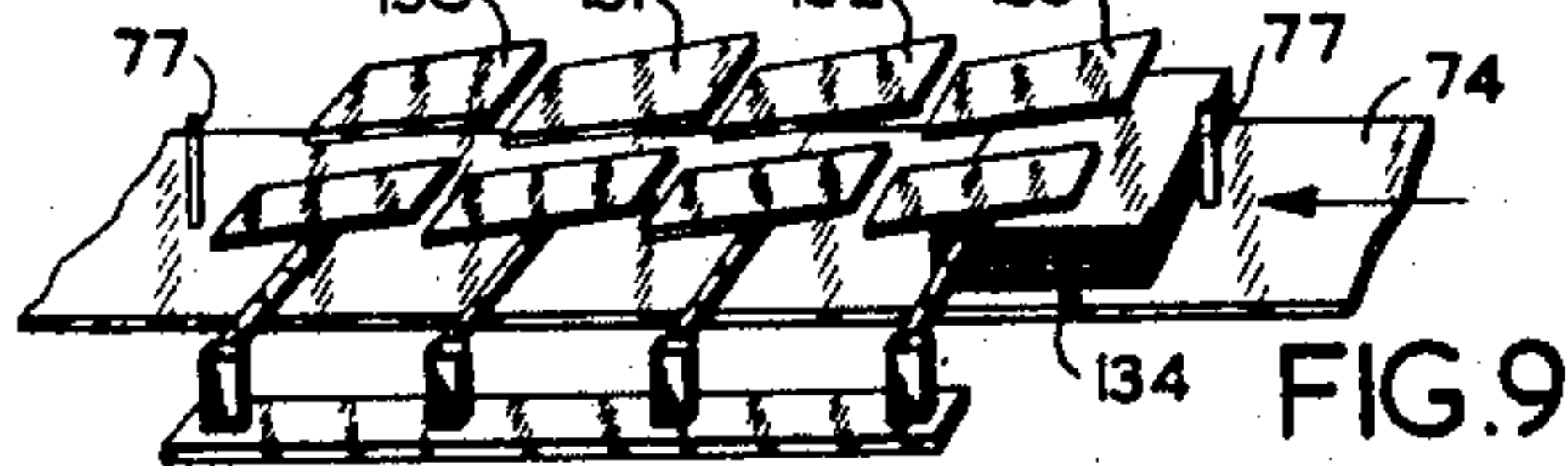
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INVENTOR

Jorgen V. Carstens
BY *Stevens Davis Miller & Mosher*
ATTORNEYS

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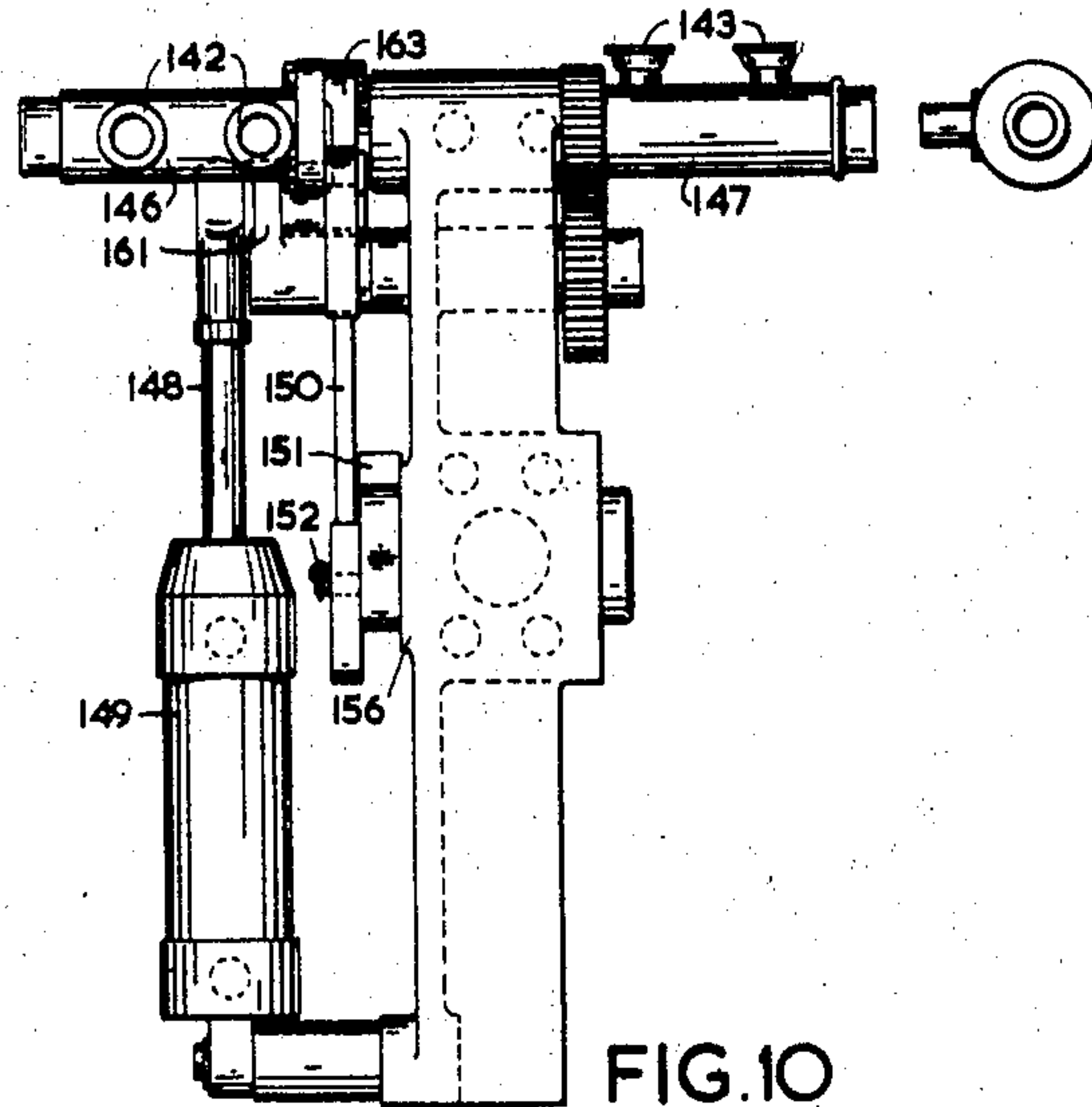


FIG. 10

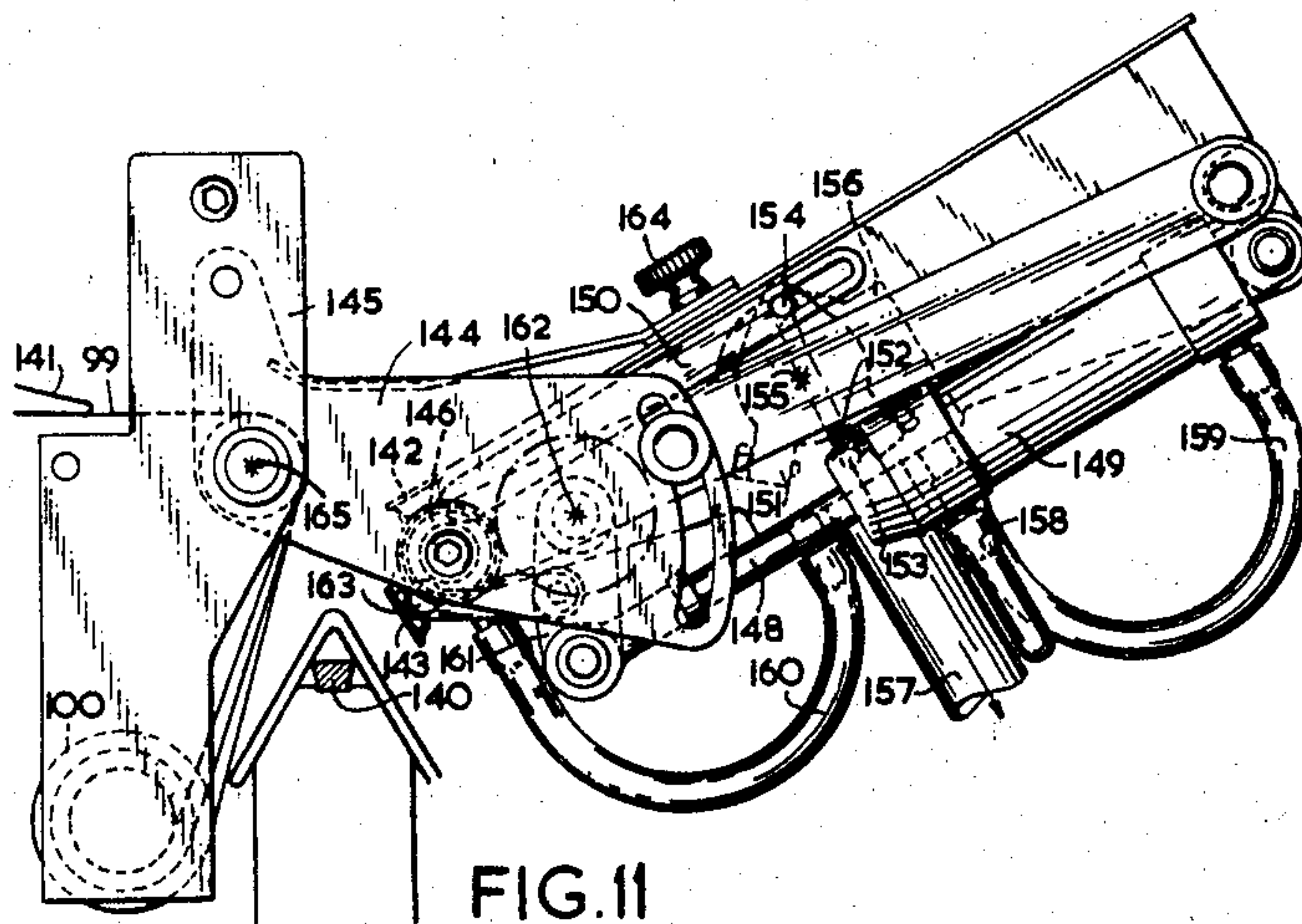


FIG. 11

INVENTOR

Jorgen V. Carstens

BY *Steen, Davis, Miller & Mosher*

ATTORNEYS

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3,441,267

METHOD OF DELIVERING SUPERIMPOSED FOLDED SHEETS AS PREPARED BOOKS

Jørgen V. Carstens, 22 Anettevej, Brabrand, Denmark
Continuation of application Ser. No. 254,238, Jan. 28, 1963. This application Nov. 26, 1965, Ser. No. 509,923
Claims priority, application Denmark, Feb. 8, 1962, 596/62; Apr. 25, 1962, 1,868/62
Int. Cl. B42c 1/00; B65h 39/02
U.S. Cl. 270—45

17 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to the assembling of the pages of books in proper sequential order prior to their being bound together, wherein a group of successive pages is printed on a large sheet of paper called a signature, said signature being folded in a manner whereby the respective pages are arranged parallelly overlying each other in proper succession, the folded signature then being deposited onto a collating conveyor. According to this invention, a plurality of such signatures, each one having printed thereon a different group of pages, are folded and advanced to said collating conveyor in time-delayed sequence relative to one another whereby the respective signatures are deposited on top of one another onto the main conveyor to form a complete book of a plurality of collated signatures.

This application is a continuation of my prior application for U.S. Letters Patent Ser. No. 254,238 filed Jan. 28, 1963, now abandoned, and entitled: Method of Delivering Superimposed Sheets as Prepared Books and Machine for Use in Performing the Method.

This invention relates to a method of delivering superimposed sheets as prepared books. The term "book" is here used in the broadest sense of the word and, consequently, also comprises brochures, folders, and pamphlets, and the like units made of folded sheets, which may be compiled by being laid on top of, or sandwiched between, each other. The term "a prepared book" means printed sheets assembled according to signatures in the proper numerical page order and, consequently, ready for being assembled in some appropriate manner, for example, by binding or by means of sewing thread or stitching wire.

Methods and machines are known where a paper web is printed, folded, cut and collated in a continuous operation. These machines are very expensive and can only be used for certain jobs. This invention is not concerned with such special machines and methods. On the contrary, it is an object of the present invention to improve the methods which are today used for solving the multifarious tasks with which this industry is commissioned, and which are solved by a combination of methods which include such operations as folding, cutting, opening, picking-up, collating etc.

The working cycle which is employed from the moment when the printed sheets are available for working until a prepared book issues from the machine is, by a frequently applied technique, as follows: The printed sheets are one by one fed to one or more folding machines which perform the folding and deliver stacks of folded sheets which are subsequently bundled and stored until a stock of the different folded sheets is provided for use in the production of a volume of books. Each stack of the stock contains only sheets of the same signature. If, for example, each sheet comprises 16 pages, the first stack contains only sheets bearing the page numbers 1-16, the next stack of sheets page numbers 17-32 etc. When the books are to be picked up and collated, the operators bring supply stacks of the various folded sheets up to the picking-up or collat-

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ing machine which is put into operation and which, gradually as the sheets are taken from the supply stacks, are fed with fresh stacks of folded sheets taken from the storage. The collating may be effected manually or by means of gripping members which simultaneously grip a sheet from each supply stack and feed them to the assembling conveyor. When such collating machine is put into operation, the first set of books less one will be incomplete.

An object of the present invention is to simplify this method which commences at the inlet of the sheet folding machine and terminates by the delivery of the collated books to be further worked, for example, by sewing, stitching, or binding.

It is a further object of the invention to provide a flexible machinery which may be readily adapted for solving the many tasks of different nature which may be given.

The invention is based both on the recognition that the heretofore used methods in the working of flat sheets have either required expensive special machines or have necessitated troublesome transportations and space-consuming storages, and on the recognition that it is possible by making a quite simple modification in the known methods, to avoid bundling, storage and transportation to and from supplies and to create the possibility of working, by means of only slightly modified standard machinery, flat sheets for the most different purposes, and, at any time, with a minimal force of machinery.

The characteristic feature of the invention is that the flat sheets from piles of sheets are parallel folded completely one at a time to form double, triple or multiple sheets, and that the said completely folded sheets are without intermediate stacking transferred directly sheet by sheet unto a main conveyor mechanism where they are assembled to form books.

The method according to the invention comprises a number of variations which may be used in dependence on the job to be performed. By way of example, it should be noted that a folded sheet may be cut into one or more sheet units prior to its being transferred to the main conveyor mechanism on which the assembling of sheet units takes place. Moreover, the sheet units may be placed astride on the main conveyor mechanism or in a plane position. In the former case the folded sheets are opened so much that they can easily be placed astride on the main conveyor mechanism.

The method according to the invention moreover provides the possibility of producing different books in one and the same machinery and thus a better utilisation of the capacity of the machinery. In the production of books of paper having a gramme weight exceeding a certain value, it has heretofore been necessary to submit to the drawback that the sheets may easily adopt an irregular position when they have been folded more than a certain number of times. This drawback may be overcome by the method according to the invention in that the number of folds may be reduced. It is of importance especially in threadless binding that the individual folded sheets do not contain too many pages.

The plane printed sheets which constitute the initial elements for the treatment by the method according to the invention, must be so printed that the pages will be arranged in the proper numerical order when the sheet units belonging to one group of signatures cut from one and the same printed sheet are laid on top of each other. Where, for example, the initial element is a sheet which comprises 32 pages and which is to be parallel-folded, the first group unit must contain pages 1-8, the second pages 9-16, the third pages 17-24 and the last pages 25-32. In this case the plane sheet is folded twice and cut into four sheet units. Within the scope of this invention the

number of folds in the sheet and the number of sheet units can be varied according to purpose.

Further the invention relates to a machine for performing said method comprising one or more sheet folding machines, one or more secondary conveyors and a main conveyor on which the completely folded sheets are assembled to form books. Controlling means controls the timing of the delivery of the completely folded sheets on to the main conveyor. The number of sheet folding machines is dependent on the job to be performed, and the machine may be so arranged that sheet folding machine units and other equipment may be connected or disconnected in compliance with requirements. The sheet folding machines may be of the type known per se for making parallel-folds or cross-folds, and a machine according to the invention may include sheet folding machines or either type.

One embodiment of a machine according to the invention comprises only one single sheet folding machine delivering parallel folded sheets that are cut into a number of juxtaposed sheet signature units.

The main conveyor mechanism may be of any appropriate type, for example, a belt comprising, if required, catchers of any applicable form or a saddle conveyor such as a V-belt, which, if required, may likewise be provided with catchers. The first-mentioned main conveyor mechanism may be used for assembling the folded sheet signatures which in the plane state are laid on top of each other while the last-mentioned embodiment may be used for assembling sheet signatures arranged inter-jacent astride the conveyor.

The means for controlling the folding machines and for the secondary conveyor in dependence on the travel of the main conveyor mechanism may be of any appropriate kind. The first folding machine may be coupled to the main conveyor mechanism while the successive folding machines may be controlled by means of feelers, for example, a light source and a photo-cell activated by a group of sheets compiled on the main conveyor mechanism.

The machine according to the invention comprises two control functions which ensure the assembling of the sheet units on the conveyor mechanism. The first function is the one ensuring that a group of sheet units cut from one and the same folded sheet arrive at such proper time at the main conveyor mechanism as to be assembled there. To this end, the machine comprises means for controlling the delivery of the different sheet units, which means includes a secondary conveyor for conveying mutually differently the various sheet units so that said sheet units will, consequently, be assembled into books on the main conveyor mechanism. The other function is the previously mentioned control which causes a group of sheet units already present on the main conveyor mechanism to actuate the subsequent folding machine to deliver a fresh group of sheet units.

The main conveyor mechanism moves continuously and preferably with adjustable velocity transversely to the direction of feed of a group of sheet units from a folding machine. In a machine according to the invention care is taken to ensure that the sheet unit first picked up by the main conveyor mechanism moves to the place where the subsequent sheet unit is picked up, whereupon the two sheet units thus assembled or collated move to the place where the next-following sheet unit is picked up etc. The mutual time delay required in the delivery of the sheet units leaving one or more of the sheet folding machines simultaneously may be obtained in many different ways, for example, by the sheet units being carried by secondary conveyor means having feeding mechanisms travelling at different speeds. However, the secondary conveyor means may also convey at constant speed but in diverging directions. The directions may, however, also be parallel in which case the relative movement of the various sheet units may be delayed by means of stop which is removed at

different times so that after the releasing of the first sheet unit a certain time lapses before the second unit is released, etc. In the case of a secondary conveyor including an opening device the time delay is preferably obtained by this device while the first part of the secondary conveyor delivers the completely folded sheets to trays at the input side of the opening device.

If the main conveyor mechanism is of the kind feeding the folded sheet units in a riding position, said mechanism being, for example, a chain or a V-belt, there is expediently between the folding machine and the main conveyor mechanism provided a secondary conveyor comprising an opening mechanism which opens the folded sheets so much that they can be delivered in a riding position to the main conveyor mechanism. The opening mechanism may comprise one or more rotatable suction cups engaging the sheet units brought over and above the main conveyor mechanism by the secondary conveyor. By the engagement with the suction cups a sheet will operate as a valve, and interrupt, when closing the suction opening, the admission of false air flowing into the suction cup prior to the arrival of the sheet. This has the effect that a cylinder with piston is put under vacuum and by movement of the piston turns the suction cup so that the folded sheet is opened. At the termination of the turning, a valve is changed over by means of a snap valve switch in such manner that suction air is now admitted to neighbouring suction cups which are to open the next-following sheet unit, so that the process may be repeated in that the valve which effects the switching over is this time moved in the opposite direction.

Moreover, the invention relates to a folding machine for use in a machine as here dealt with, and this folding machine is characterised in that it comprises knives for cutting a folded sheet into a number of juxtaposed sheet units, and a feeding device for advancing mutually differently neighboring sheets of a group originating from a cut folded sheet so that at the discharge end of the feeding device they are delivered at mutually different times. This folding machine may be provided with a conventional outlet for folded sheets so that the machine may be used in the conventional manner.

The invention will in the following be explained in detail with reference to the accompanying purely diagrammatical drawing where

FIGS. 1-3 illustrate the principle of the invention by means of different embodiments,

FIGS. 4 and 5 illustrate the function of the opening device for opening the folded sheet units so that they can be placed in a riding position on a main conveyor mechanism, FIG. 4 being a side elevation of the machine, and FIG. 5 being a top view of the same machine,

FIG. 6 shows a machine according to the invention comprising a number of sheet folding machines and a main conveyor mechanism,

FIG. 7 is part of a machine according to the invention comprising two buckle folding machines, a conveyor mechanism, and feeding devices between the folding machines and the conveyor mechanisms,

FIGS. 8 and 9 are arrangements for ensuring the assembling in the proper numerical page order of simultaneously picked up groups of sheet units,

FIG. 10 is a bottom-view of an opening mechanism for opening folded sheets to be arranged in a riding position on the conveyor mechanism, and

FIG. 11 is a side elevation of the opening mechanism shown in FIG. 10, viewed in the longitudinal direction of the conveyor mechanism.

In FIG. 1, 1 and 2 are supplies of printed sheets to be introduced into two folding machines 3 and 4. The number of folding machines may be chosen in accordance with requirements.

In the method according to the invention, the folded sheets are, besides being completely folded in the machines 3 and 4, cut such as it is indicated in FIG. 2, which

shows the still coherent folded sheet containing the book pages 1-16; 17-32; 33-48; and 49-64, respectively. The cutting is effected immediately after the folding along the three dotted lines A, B and C, and the resulting four folded sheet units D, E, F and G each comprising 16 pages are by means of a feeding device, also denoted a secondary conveyor, advanced in diverging directions as indicated by arrows H, I, J and K, so that they are brought unto another conveyor mechanism, e.g., a conveyor belt 5, see FIG. 1, which travels in the direction of the arrow L in FIG. 1. This latter conveyor on which the signatures are collated is denoted the main conveyor or collating station.

The movement of the conveyor belt 5 controls the delivery of the cut folded sheet units from the machines 3 and 4 for instance by means of mechanical or electrical means, so that a group of sheets, for example, D, E, F, G present on the conveyor belt has just been advanced one unit when the next following group is fed to the conveyor belt. It will be seen that on the top of a sheet D there will gradually be stacked sheets E, F, G etc., so that a complete prepared book will issue at the end of the conveyor belt. If the book has 128 pages the machine 4 delivers the pages 65-80; 81-96; 97-112 and 113-128 on top of the stacks of 64 pages passing by.

It will be seen that by this method it will not be necessary to bundle and store the folded sheets delivered by sheet folding machines prior to the commencement of a picking-up process in that the folded sheets of different signatures are immediately after folding fed to the main conveyor mechanism to be collated. It is characteristic that in the example shown each sheet folding machine delivers sheets of different kinds or signatures in a suitable number. A buckle folding machine which is preferred in this case fold the sheets in a number of parallel folds. Parallel folding machines are known to the man skilled in the art and need not be described here. However it should be pointed out that buckle folding machines can work fast but they are bound to work sheets.

Existing parallel folding machines can through minor modifications and by being provided with an auxiliary device which performs the cutting and mutually different feed of the cut sheets, be adapted for use in connection with the method according to the present invention.

By the method according to the invention it is possible to adapt the machines for widely different jobs, in that a folding machine may easily be adjusted to issue two, three or more sheet units formed by cutting. Furthermore, it is possible to print pages of different books on one and the same sheet if only it is done in such a manner that such different pages are separated by the cutting operation.

The spreading of the sheets of a group may be effected in different ways, for example, by delayed delivering of the units of a group onto a conveyor belt, by mutually different lengths of the feeding paths for the different units etc. Diverging paths are consequently not definitely required.

The buckle folding machines 3, 4 etc. need not be arranged at mutually definite distances because the delivering of the groups can be controlled by the groups themselves. The machine is, therefore, not bound to operate at a definite invariable rhythm. A controlling like the one here mentioned is intimated diagrammatically in FIG. 1 by means of a photocell 6 which through a line 7 is connected with the folding machine 4 in such manner that the folding machine in a manner known per se is actuated when a pulse is received through the line 7 and, consequently, initiates the folding of a sheet which in the folded state is by means of a secondary conveyor, not shown, advanced towards the main conveyor mechanism 5. The pulse from the photo-cell is generated when the stack, which on the conveyor belt is designated by G and which consists of four superim-

posed folded sheet units G, F, E and D, cuts a light ray from a source, not shown, to the photo-cell 6. It will be directly seen that by this controlling the folding machines 3 and 4 can be placed mutually at any distance. The said control which is here shown as a photocell control, may be effected in any other suitable manner, electrically, mechanically or pneumatically.

FIG. 3 shows an example corresponding to that shown in FIG. 2, but showing only a single folding machine 40 and a conveyor mechanism 41, for example, a V-belt on which the folded sheets are collated riding astride the V-belt in interjacent positions. In the figure it is intimated that a sheet unit 42 which is advanced by a secondary feeding device, not shown, is on its way to a position over and above the stack of interjacent sheets 43 and 44 already placed on the main conveyor mechanism, in which position the sheet 42 is gripped by a suction device opening the folded sheet and placing it astride on top of the sheet 43. The suction device will be explained in detail below with reference to FIGS. 10 and 11. The other sheet unit 45 belonging to the group of sheet units 42 and 45 which have been delivered by the folding machine 40 is advanced with delay, e.g., in the manner to be explained in conjunction with FIG. 7, and is laid on top of the sheet unit 42.

A line 46 and a micro switch 47 diagrammatically indicate the control means by which the folding machine is made operative for delivering the sheet units 42 and 45. The micro switch 47 has in the example shown been actuated by the passage of the sheet stack consisting of the folded sheets 43 and 44 which by the main conveyor mechanism 41 is moved in the direction of the arrow 48.

In the example shown in FIG. 3 there are two sheet units 42 and 45 in a group, but the group may comprise any number of sheet units, and like wise any number of folding machines 40 may be employed. Moreover, the equipment may comprise a supply device for covers of a more rigid material, which is ultimately advanced and placed astride on top of the stack of collated folded sheets on the main conveyor mechanism.

With a view to further illustrating the explanation given in conjunction with FIG. 3, FIGS. 4 and 5 show diagrammatically a buckle folding machine comprising a sheet stack 51 and a suction roller 52 which, when made operative, feeds a sheet to the folding unit which comprises rollers 53, 54, 55 and 56 and folding pockets 57 and 58. Such folding unit is known per se and requires, consequently, no further explanation. The buckle folded sheets are cut into identically folded sheet units 59 and 60 which in a manner previously described, cf. moreover the following description of FIG. 7, are advanced to the entrance or receiving tray of an opening device forming part of a secondary conveyor and which is shown as a cylinder 61 having suction cups 62 and 63 which are so mechanically interconnected that the suction cup 63 moves anticlockwise when the suction cup 62 moves clockwise, and conversely. When the sheet is sucked fast thereagainst, and the suction cup commences its clockwise movement and consequently moves the sheet 59 downwards so that the latter is placed astride on top of the sheets 64 and 65 already present on the main conveyor mechanism 66. It should be mentioned that the opening device can be used as a simple conveyor e.g., by feeding the sheet with the fold as the leading edge. Thus the sheets can by the same device be placed in flat position on a band conveyor. This shows the flexibility of the arrangement.

The sheet 60 which has been advanced with delay in relation to the sheet 59, moves from the full-line position shown in FIG. 5 to the dotted-line position while the main conveyor mechanism 66 with the stack consisting of sheets 65, 64, and 59 proceeds continuously, so that the sheet stacks 65, 64, 59 register with the sheet 60 when said latter sheet 60 is delivered to the main conveyor mechanism by the suction device. The sheet 60 is opened

by the suction cup 63 which, when the suction cup 62 turned the sheet 59 downwardly over the conveyor mechanism, turned in the opposite direction so as to take up a stand-by position for the reception of the sheet 60. On the basis of FIGS. 10 and 11 it will later on be explained how the opening device with the suction cups is arranged.

In the example of a machine according to the invention illustrated in FIG. 6, there are a number of folding machines 71, 72, and 73. The folding machines may be of any type known per se such as they are commercially available they shall, therefore, not be described in detail. The principle of a knife-folding machine should be briefly mentioned, but it is emphasized that the invention is not limited to the employment of a folding machine of this type. The folding machines may be of the same type or of different types. In the interest of simplicity it is assumed that the machines as used in this example are alike.

Transversely of the direction in which the folding machines 71, 72 and 73 issue the folded sheets, provision is made for a main conveyor mechanism or assembling conveyor 74, which is common to all folding machines. The term "assembling conveyor" indicates that on this conveyor the assembling or collating of the folded sheets from the different machines takes place, the assembled sheets being compiled to form prepared books. The assembling conveyor may be of any appropriate kind. It may, for example, be a conveyor belt or, as indicated by the embodiment shown in the drawing, a stationary table arranged along the folding machines, which table is at its middle provided with a longitudinal slit 76 in which catchers 77, e.g., in the form of pins, are displaceable. The catchers may be provided on a band 79 or chain which is moved along a closed path by a motor M, preferably a variable-speed motor. The surface of the table 75 on which the sheets are supported during the feeding, is at an angle to the horizontal plane so that the sheets will with one edge engage a stop 78. The sheets are hereby prevented from tipping during the feeding as a consequence of the catchers 77 not engaging the middle of the side edge of the sheet.

In the folding machine 71 is a supply stack 80 of plane printed sheets to be folded. A suction roller 81 feeds the sheets one by one from the supply stack 80 to a first pair of rollers 82, from which a sheet is passed on until it is stopped against a stop 83. By actuation by a knife 84 the sheet is folded through a pair of rollers 85 and is passed on to the next pair of rollers 86, the timing of the insertion between the rollers being determined by the movement of a folding knife 87. Since the functions as described are known from the conventional folding machines, a more detailed description thereof is not required here. The ready-rolled sheets leaving the rollers 83 may either be passed directly on to the assembling main conveyor 74 or may be stopped in the position indicated by 88 by means of a stop 89. The feeding of the folded sheets to the assembling conveyor may be effected by means of a conveyor belt, see FIG. 7.

In the known folding machines, the different steps of folding are effected automatically and in timed relationship. By the machine according to the invention, the function of the folding unit is controlled in dependence on the main conveyor mechanism or by the sheet or sheets advanced thereon. This is diagrammatically indicated in FIG. 6 by a micro switch 90, the feeling member of which protrudes into the path of the catchers 77, and which controls different functions in the folding unit. If there is a stop 89, the micro switch 90 is used for releasing the sheet 88 by the stop 89 being, for example pneumatically, withdrawn from the path of the sheet 88, which, for example, may be supported on a continuously moving conveyor belt which, as soon as the stop 89 is removed, by friction brings the sheet along and passes it on to the main conveyor mechanism 74. The same

pulse which controls the stop 89 may be used for controlling the folding knives 84 and 87 and the suction feeder 81, such as it is diagrammatically shown by lines 91, 92 and 93. The pulses expediently control electromagnetically operated couplings which when engaged transfer power, for example from a continuously rotating shaft, to the different steps of the folding devices and the suction feeder.

Instead of electric controlling means, mechanical or pneumatical controlling means may be employed.

Provided that the folding units 71, 72, 73 etc. are correctly placed in relation to each other and to the assembling conveyor 74, one could suggest the use of a single micro switch 90 for controlling all folding units. In adjusting the machine for other sizes or jobs of a nature different from those preformed with the machine under these circumstances, difficulties are, however, encountered. These difficulties can be overcome by introducing appropriate time delays in respect of the pulses applied to the different folding devices. However, according to the invention it is preferable to use a control device for each folding unit so that restriction to a definite distance between the catchers 77 is avoided. An adjustment of the speed of the main conveyor mechanism 74 will in the stated construction automatically involve the adjustment of the speed at which the folding units feed folded sheets to the main conveyor mechanism. By making the function of a given control member, except for the first one, dependent on the preceding control member having been operative, it is ensured that all collated books are complete.

Even if the described embodiment employs micro switches, it is evident to a person skilled in the field of the invention that the control device may use any feeler of mechanical or electrical nature, for example, a photocell and associated light source. Further the sheets proper advanced by the main conveyor mechanism may be caused to actuate the feeler so that a restriction to fixed mutual distances between the stacks of folded sheets on the feeding device is avoided.

As an example of mechanical control means, can be mentioned a common cam shaft having adjustable cams, one for each folding unit. Each cam is adjusted to transfer a starting pulse to the folding unit concerned at the proper time. The cam shaft is connected with the driving mechanism for the main conveyor mechanism 74 so that the speed of the main conveyor mechanism determines the speed at which the individual folding unit operates.

By the controlling of the folding units, indicated by the embodiment shown in FIG. 6, it is ensured that a sheet has taken up a stand-by position at each step of the folding operation, so that it is not necessary to wait for the travel of a sheet quite up from the stack 80 and to the position 88 each time a control pulse occurs. Consequently, the working speed is first and foremost determined by the speed at which a folded sheet is carried from the pair of rollers 86 and onto the main conveyor mechanism 74 or only the time the folded sheet takes to travel from the position 88 and onto the conveyor mechanism 74. In the case of cross-folding, the sheet issuing from the folding unit is generally not being cut as in the case of parallel-folding, and consequently no difficulty is encountered in ensuring the compiling in proper numerical order of the pages coming from the individual folding units. Compiling in proper numerical order of the sheets coming from the different folding units is ensured by the design of the machine. In the case of parallel-folding, the individual flat sheets are cut into two, three or more parts to be compiled on top of each other or inside each other on the conveyor mechanism. According to the invention, provision is therefore made for an auxiliary device for ensuring the desired compilation of the pages in proper numerical order. FIG. 7 shows purely diagrammatically an embodiment of such auxiliary device.

In FIG. 7, a folding unit 71 delivers parallel-folded

sheets cut into four separate sheet units 95, 96, 97 and 98 to the main conveyor mechanism 74. When leaving the folding device the sheet units are juxtaposed but since the said four units are first brought on to a secondary conveyor or feeding device which is divided into four parallel sections each operating at different speeds, the advance of the sheet unit 96 is delayed in relation to the sheet unit 95, and that of the sheet unit 97 in relation to the sheet unit 96, and that of the sheet unit 98 in relation to the sheet unit 97 to the main conveyor mechanism so much that the sheet units, when delivered to the main conveyor mechanism, are assembled thereon. Minor irregularities in the assembling are corrected by the catcher 77.

In the example illustrated in FIG. 7 the secondary conveyor device feeding the sheet units to the main conveyor mechanism 74 comprises four pairs of conveyor belts, two for each sheet unit. Each conveyor belt 99 passes over three rollers, of which only two, 100 and 101, are shown in the drawing. The roller 101 is an idle roller whereas the roller 100 is a driving roller which by a common shaft 102 is connected with a driving roller 103 which via a V-belt is driven from a motor in the folding unit 71, preferably the motor driving the individual parts of the folding unit. The shaft 102 drives the main conveyor mechanism 74 via a gear mechanism 105. The main conveyor mechanism 74 may, however, also have a driving unit of its own, as in such case care should only be taken to ensure the required synchronism between the speeds of the main conveyor mechanism and the conveyor belts 99. The differences in speed of the various pairs of belts are provided by using rollers of different diameters. By using an engageable and disengageable gear mechanism, the secondary conveyor may be changed over readily from work with parallel folding to work with cross-folding and vice versa. The measure as shown in FIG. 7 affords the advantage that the distance between the catchers 77 need not be as great as the total width of the sheet units 95, 96, 97 and 98.

FIGS. 8 and 9 show another possibility of assembling juxtaposed sheet units in the proper numerical page order. Above the main conveyor mechanism 74 and opposite each of the folding units, is arranged a stepped table which in the case shown comprises four bipartite inclined receiving surfaces 130, 131, 132 and 133, on which the four sheet units originating from the same folded sheet are delivered in side-by-side relationship. A catcher 77 which is secured to the main conveyor belt 74 brings the four sheet units together in the proper numerical page order during the travel of the main conveyor mechanism 74, on top of a book part 134 assembled in a previous stage and advanced by the main conveyor mechanism 74 when said book part reaches the end of the stepped table.

In the embodiment shown in FIG. 9, the sheet units are compiled one by one on the subjacent book part in the sequence 133, 132, 131, 130 in that the conveyor belt 74 moves in a direction opposite to that of the conveyor belt 74 of FIG. 8.

FIGS. 10 and 11 illustrate an arrangement to be included in the secondary conveyor if the sheet units are to be placed astride and interjacent on a main conveyor. The main conveyor is a V-belt 140 shown in cross section in FIG. 11 and traveling along a closed path between two pulleys, not shown, located in a vertical plane. The main conveyor 140 is located at the end of a feeding mechanism, e.g., like the one shown in FIG. 7, comprising conveyor belts 99 which advance sheet units 141 in a direction perpendicular to the main conveyor 140 and deliver them above the main conveyor 140 so that they move downwardly in the direction of said main conveyor by gravity. As the sheets are folded, they will have to be opened so much that they can be placed astride on the main conveyor, and to this end provision is made for an opening unit comprising two sets of suction cups 142

and 143, which are so connected through gears that the suction cups 143 will turn upwardly when the suction cups 142 turn downwardly. When the suction cups are in top position 142, suction air is admitted to them while the suction air inlet is closed when the suction cups are in the lower position 143. The suction cups operate as valves so that the opening unit will become operative when a folded sheet engages a suction cup and, consequently, closes the opening thereof.

In the example shown, the opening unit can be turned around a hinge 144 at the end of the bed of the feeding mechanism 145. The suction cups 142 and 143 are mounted on two rotatable members 146 and 147 respectively said members being interconnected by means of gear wheels so as to rotate in mutually opposite directions under the influence of a piston rod 148 of a piston, not shown, in a vacuum cylinder 149, to which vacuum can be connected above as well as below the piston. The mechanism is adapted for autoreversion of the vacuum supply by means of a pull rod 150 and a snap reversing device 151 which is actuated by spring 152 secured at one end to a fixed point 153 and at the other end to a point 154 of the snap reversing device and so positioned that a turning of said device around the centre of rotation 155 first stretches the spring until its axis has passed the centre 155 and thereafter contracts again. As the spring is a tension spring the reversing device has, consequently, two resting positions.

The snap reversing device 151 actuates a reversing valve 156 to which vacuum is supplied through a pipe 157 and from which two pipes 158 and 159 extend to one and the other end, respectively, of the vacuum cylinder 149, and two pipes of which only one, 160, is shown in FIG. 11, which supplies vacuum to one or the other, respectively, of the two pairs of suction cups 142 and 143. In the interest of perspicuity, the connecting pipes are not shown in FIG. 10.

In the position shown in FIG. 11 vacuum is supplied to the suction cups 142, and the piston of the cylinder 149 is at its top position. When a sheet engages the suction cups 142, the sheet is sucked fast and closes the inlet of false air through the suction cups so that the vacuum will be capable of moving the piston in the cylinder 149 towards the bottom thereof. This has the effect that the piston rod 148 moves into the cylinder 149. The piston rod 148 is rotatably connected with a lever which at the other end is rotatable on a fixed axis 162. The lever 161 is by means of a link 163 connected with the rotatable member 146.

The entire unit as described can by releasing a finger screw 164 be swung on an axis 165 into a position, where the unit will not constitute a bar to performing other jobs with the machine, e.g., when using a feeding device different from the one shown.

The opening unit need not be of the construction as here described. Instead of the suction cups it will, for example, be possible to use suction cylinders in which the reversing valve is built-in.

On the whole, the invention is not restricted to the constructions as here shown. It is within the scope of the invention to vary the constructions if only the principal idea of the invention is maintained, namely, that the flat sheets are directly, subsequent to the folding operation, assembled to form a book.

What I claim is:

1. A method for collating in superimposed relationship a plurality of folded sheet signatures to form a prepared book read for binding, comprising the steps of:

(a) completely folding a series of mutually different signatures;

(b) depositing the folded signatures onto a conveyor means which in turn advances the completely folded signatures of a series separately from each other along respective substantially parallel paths adjacent each other towards a continuously moving collating

conveyor, the respective signatures of one and the same series being advanced in successive time-delayed sequence relative to one another whereby they arrive at the collating conveyor successively at respective longitudinally spaced apart points along the path of travel thereof;

- (c) successively depositing each signature of a series onto the collating conveyor and advancing the conveyor transversely to the direction in which the signatures are advanced along said paths thereof whereby each succeeding signature is deposited onto a preceding signature of the same series which has previously been deposited onto said collating conveyor;
- (d) correlating said depositing of the signatures in time-delayed sequence to the movement of the conveyor independently of the timing and completion of any commenced folding action.

2. The method of claim 1, wherein the series of signatures are cut from a single flat sheet, and including the steps of:

- (e) feeding a flat sheet from a single pile of such sheets to a folding machine;
- (f) folding and cutting said sheet so as to form a series of completely folded signatures;
- (g) proceeding according to steps (b) to (d) in claim 1 whereby the series of signatures cut from a single sheet are deposited one on top of the other on said collating conveyor.

3. The method of claim 1, wherein the series of signatures are cut from a plurality of flat sheets, and including the steps of:

- (e) feeding a flat sheet from each of separate piles of such sheets to respective folding machines;
- (f) folding said sheets in each folding machine to form respective completely folded series of signatures;
- (g) proceeding according to steps (b) to (d) in claim 1 whereby the respective series of signatures formed from respective different sheets are deposited one on top of the other on said collating conveyor.

4. The method of claim 1, wherein said signatures are buckle folded.

5. A method for delivering a series of folded sheet signatures from a folding means to a collating station, wherein the signatures of a series are different from each other and are to be collated in superimposed sequential relationship, said method comprising the steps of:

- (a) completely folding the series of different signatures in a folding means therefor;
- (b) advancing the series of completely folded signatures from the folding means towards a continuously moving collating station;
- (c) discharging the signatures of one and the same series onto said collating station successively one after the other and in superimposed relation one on top of the other, said discharging being independent of the folding but correlated to the advance of the signatures along said collating station.

6. The method of claim 5, wherein step (b) is carried out with the signatures of each series being advanced in delayed-time sequence relative to one another whereby they arrive at said collating station successively, one after the other.

7. The method of claim 5, wherein step (b) is carried out with all the signatures of a series being advanced simultaneously each one along a respective one of a plurality of different paths, the signatures being discharged onto said collating station at respective points spaced apart from each other along the extent of said collating station, said signatures being advanced from one of said points to the other along the extent of said collating station at a speed such that each successive signature after the first one of the same series is deposited on top of the immediately preceding signature which was discharged onto said collating station.

8. The method of claim 7, wherein said series of sig-

natures are discharged onto said collating station at respective points along a straight line which extends transversely to the direction of said paths, said signatures being advanced along said straight line at a speed such that each successive signature after the first one is deposited on top of the immediately preceding signature which was discharged onto said collating station.

9. A machine for advancing a series of different sheet signatures which are to be collated as the pages of a book as defined herein, said machine comprising: a folding means for completely folding a series of different signatures, a conveyor means for receiving said signatures from said folding means and being adapted to advance same in time-delayed sequence relative to one another for delivering signatures of one and the same series onto a movable collating station successively in time-delayed sequence relative to one another, whereby they arrive at the collating station successively at respective longitudinally spaced apart points along the path of travel thereof, and means for correlating the delivering of signatures from said conveyor means and onto said collating station to the advance of the signatures along the collating station independently of the action of the folding means.

10. The machine of claim 9, said conveyor means providing a plurality of adjacent conveyor paths which extend from said folding means to a collating station, said conveyor means being adapted to receive a series of said signatures and to carry each one along a respective one of said paths in time-delayed sequence relative to each other.

11. The machine of claim 10, wherein said conveyor means is arranged to simultaneously receive all said signatures of a series from said folding means and to advance each signature of a series along said conveyor paths at a different speed relative to each other.

12. The machine of claim 10, wherein said conveyor means comprises a plurality of conveyor belt means arranged adjacent to each other, drive means to drive said belt means at different rates of speed relative to each other.

13. A machine for collating in assembled form the pages of a book, as defined herein, said machine comprising: a folding means for completely folding a series of different signatures, a first conveyor means for advancing signatures of said series in successive delayed-time sequence relative to each other along respective adjacent paths from said folding means to a second conveyor means, said second conveyor means being continuously movable transversely across the direction of said paths, said first and second conveyor means being correlated with each other whereby respective reference points on said first conveyor means corresponding to successive signatures carried thereon arrive at said second conveyor means at successive intervals corresponding in time to the time interval required for advancing said second conveyor means the distance between successive ones of said paths.

14. The machine of claim 13, said second conveyor means comprising a relatively narrow belt adapted to fit along the fold line of a signature with the signature resting thereon in the form of an inverted-V, and including an opening means at the end of said first conveyor means for partially unfolding the completely folded signatures as they are transferred from the first to the second conveyor means.

15. The machine of claim 13, wherein said folding means is a buckle folding machine adapted to receive flat sheets from a single stack of such sheets, each sheet containing thereon a plurality of different signatures, said folding means being adapted to fold each flat sheet and to cut it into a plurality of completely folded signatures, said first conveyor means being adapted to advance the respective signatures to said second conveyor means with the folds in the signatures extending parallel to the direction of movement of the second conveyor means.

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16. The machine of claim 13, wherein said folding means comprises a plurality of buckle folding machines arranged parallel to each other, each said folding machine being adapted to receive a respective signature from a respective different stack of such signatures and to completely buckle-fold said signature.

17. The machine of claim 13, including a sensing means for correlating said folding means and said second conveyor means with each other, said sensing means being arranged to detect the presence of a signature on said second conveyor means at a particular point along the travel of said second conveyor means, said sensing means actuating said folding means.

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EUGENE R. CAPOZIO, *Primary Examiner*.
PAUL V. WILLIAMS, *Assistant Examiner*.

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