March 22, 1966 H. ACHER 3,241,829

DEVICE FOR FOLDING SHEETS OR FOILS OF PAPER OR THE LIKE

Filed May 1, 1964 6 Sheets-Sheet 1

Fig. 1

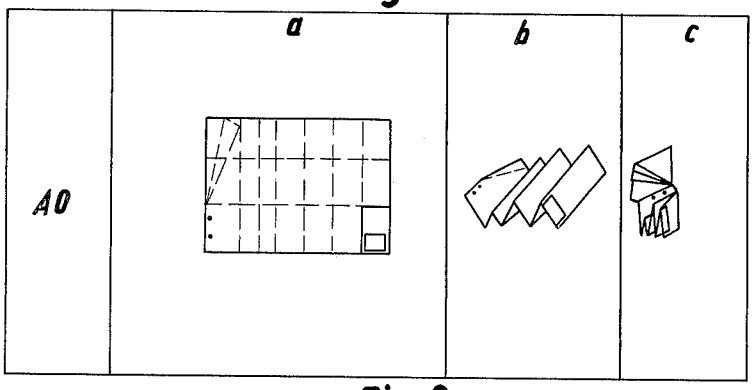


Fig. 2

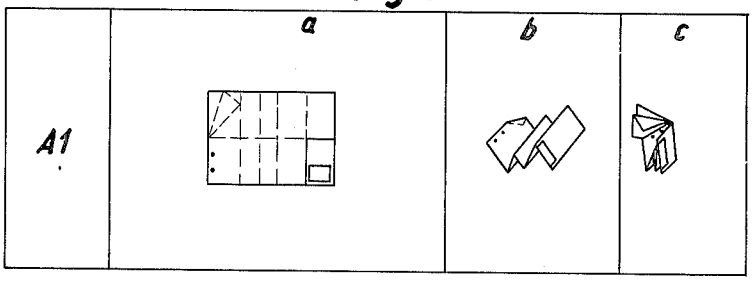
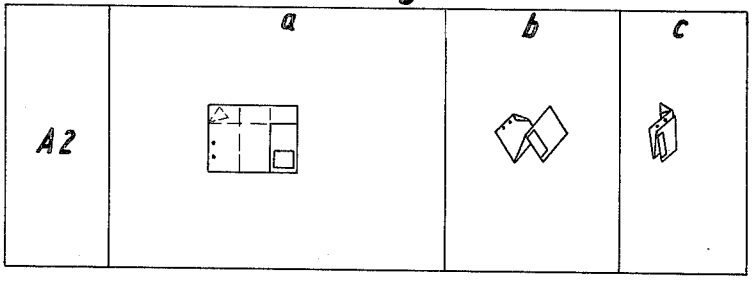


Fig. 3



DEVICE FOR FOLDING SHEETS OR FOILS OF PAPER OR THE LIKE

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Fig. 4

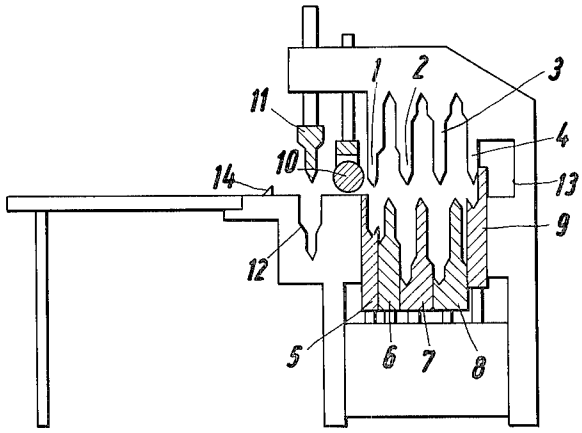
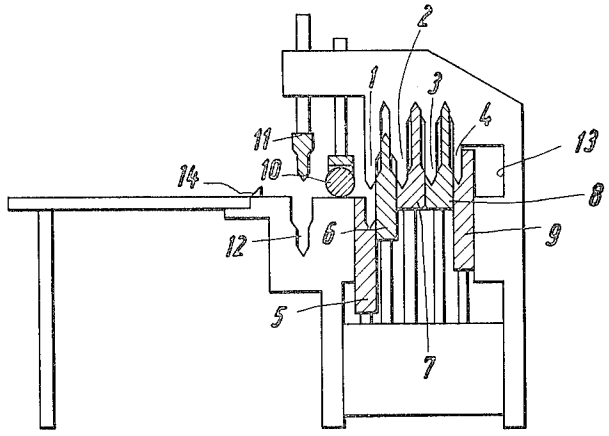


Fig. 5



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DEVICE FOR FOLDING SHEETS OR FOILS OF PAPER OR THE LIKE

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Fig. 7

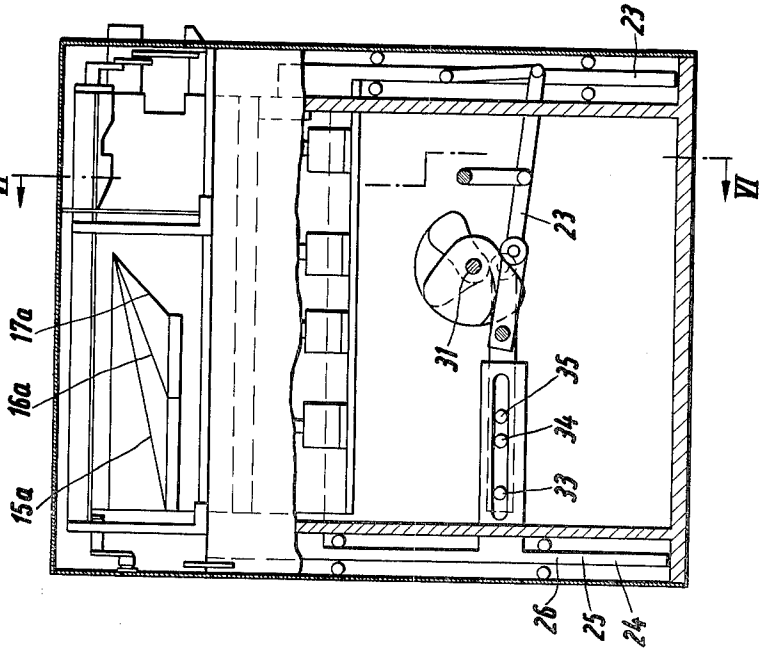
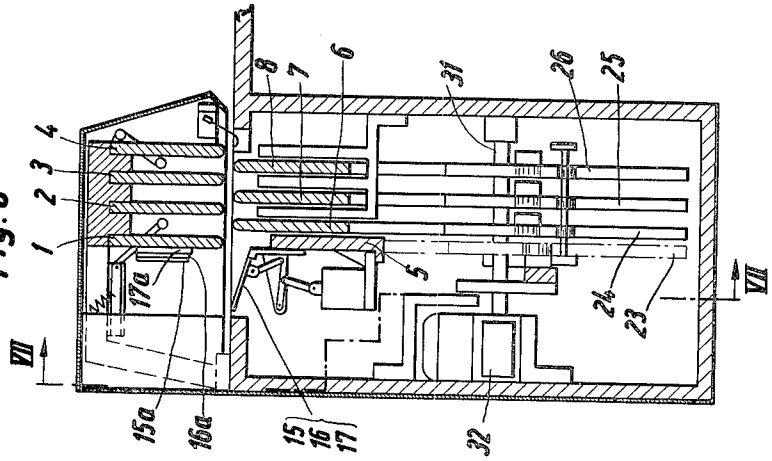


Fig. 6



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DEVICE FOR FOLDING SHEETS OR FOILS OF PAPER OR THE LIKE

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Fig. 9

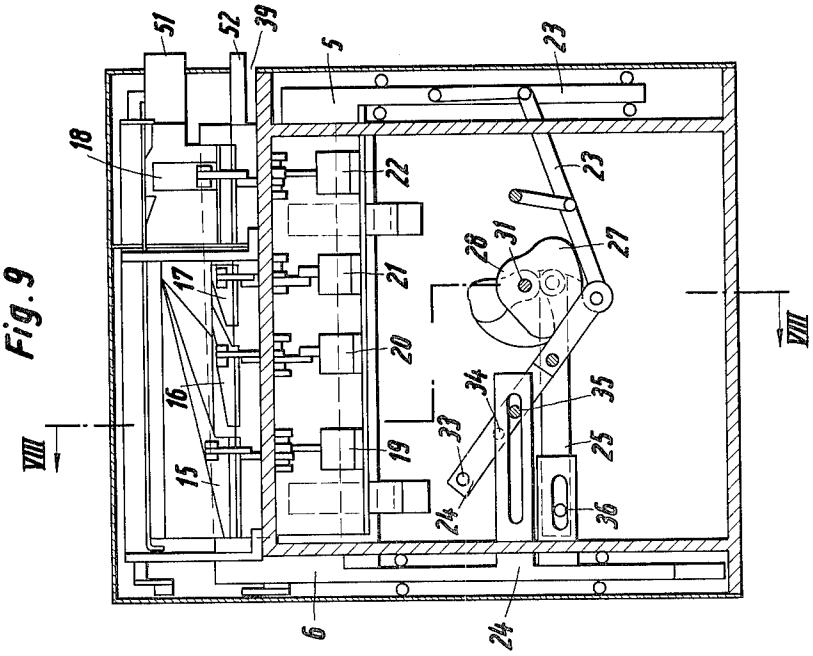
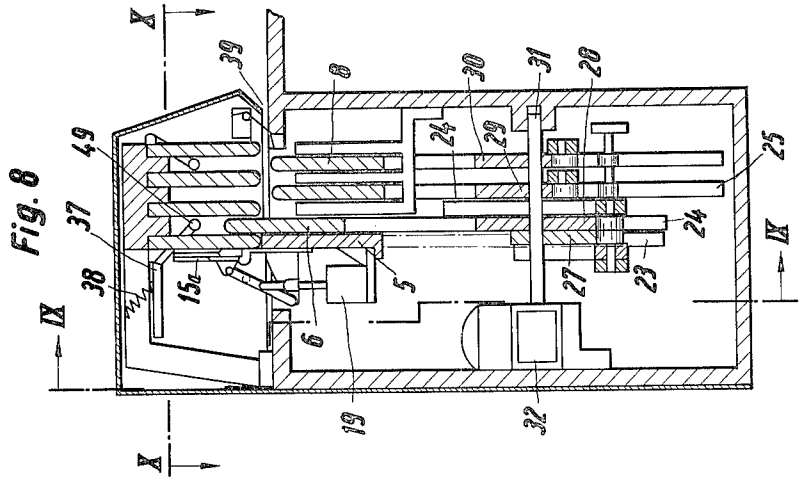


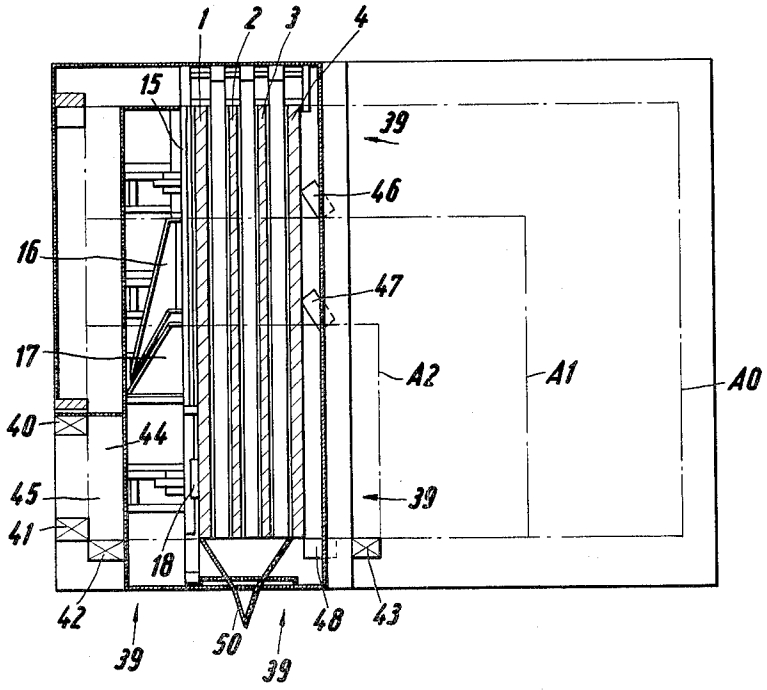
Fig. 8



DEVICE FOR FOLDING SHEETS OR FOILS OF PAPER OR THE LIKE

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Fig. 10



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DEVICE FOR FOLDING SHEETS OR FOILS OF PAPER OR THE LIKE

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Fig. 11

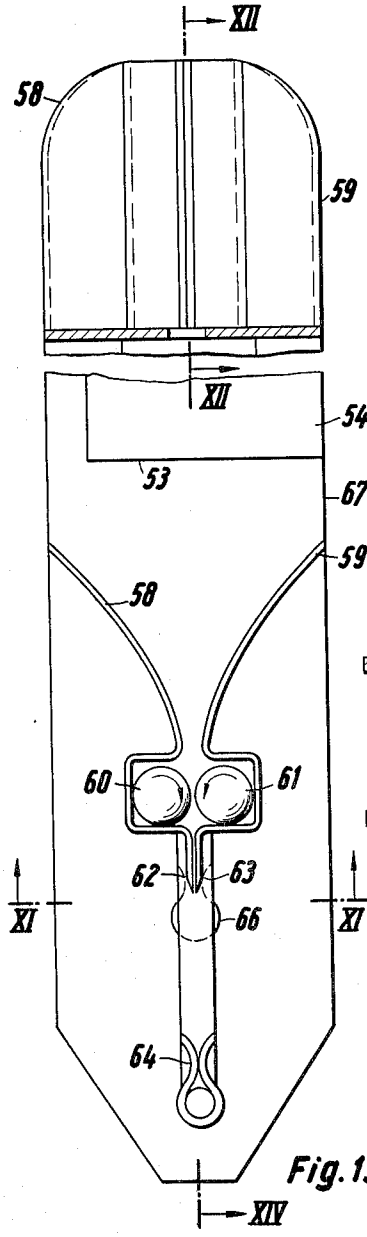


Fig. 13

Fig. 12

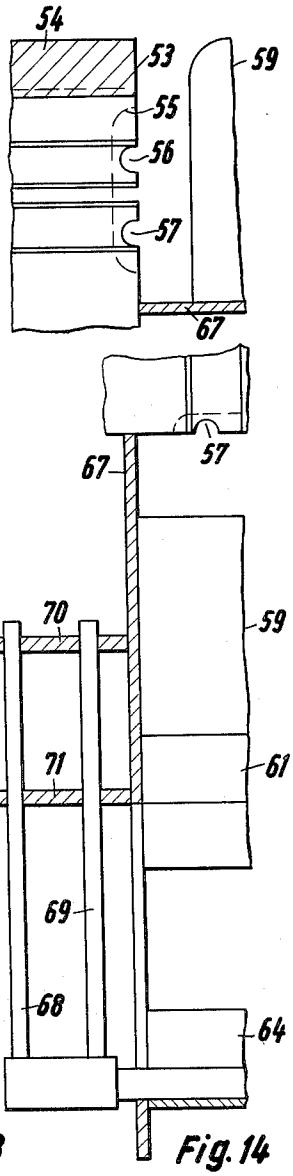


Fig. 14

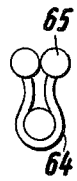


Fig. 15

United States Patent Office 3,241,829 Patented Mar. 22, 1966

3,241,829

DEVICE FOR FOLDING SHEETS OR FOILS OF PAPER OR THE LIKE

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Filed May 1, 1964, Ser. No. 364,213
Claims priority, application Germany, May 3, 1963, A 43,030; Feb. 25, 1964, J 25,337
7 Claims. (Cl. 270—61)

The invention relates to a device for folding sheets or foils of paper or the like, for instance, for folding drawings or drawing prints.

Technical drawings or prints thereof are the basic working documents in industrial and manufacturing production. Part of their complete manufacture is folding them up, more particularly for insertion in files or for dispatch in correspondence envelopes. Kinds of folding (folding patterns) are known wherein large format drawing sheets which have been folded and placed in spring-action files or lever arch files can be quite simply so spread out, without having to be taken out of the file, that the person studying them has the drawing in the correct position before him. When the drawing is folded up, the title box containing the drawing number and other particulars and usually placed in the bottom right-hand corner of the drawing lies facing upwards in legible fashion. Of course, folding patterns of this kind are relatively complicated. They are therefore seldom used correctly, either because of ignorance or because, for instance, when a print department has a large output of photoprints, there is insufficient time to fold the prints correctly. As a rule, cardboard templates are the only things available to make the folds and speed up the work. Folding devices are known but can provide longitudinal and transverse folds only at equal spacings. To alter the fold spacing a lever system must first be adjusted. However, the folding distances, once adjusted are equal to one another during a folding operation, and so the drawings thus folded merely have folds at equal distances. These known devices cannot fold drawings in a manner suitable for them to be stapled in a file.

Also known is a device for folding paper sheets or foils wherein abutments are so arranged, at equal or varying intervals, to form a bending edge on a flat baseplate as to determine the intervals between longitudinal, diagonal and transverse folds in the sheets which it is required to fold. A perforator is provided on the baseplate of the folding device, so that the abutments for the diagonal folding of the particular formats concerned also serve as abutments for the perforation. With this known device, disclosed by German patent specifications 1,121,075 and 1,124,973, sheets can be folded lengthwise and transversely at the same and/or different intervals, folded diagonally and perforated in a single working step. However, the sheets still have to be moved up to the bending edge by hand, while folding is performed by pedals being operated, so that the various folds must be performed consecutively in time. Sheet folding as provided by this known device is therefore still a time-consuming job and requires skilled operators. It is an object of this invention to provide convenient and space-saving devices for the mechanical folding of material in sheet form, the devices enabling more particularly folds to be performed at different intervals on the same sheet. Above all, it is an object of the invention to enable the difficult longitudinal and diagonal folding of technical drawings and drawing prints to be performed automatically, although supplementary means can be provided for folding the longitudinally folded sheets transversely.

The invention accordingly provides a device wherein

at least one moving folding stick is so disposed relatively to at least two stationary matching or mating elements as to be movable from a position outside the matching elements into a position therebetween and, in so doing, to move with it, in the shape of a loop, the sheet which it is required to fold and which has been introduced between the folding stick and the matching elements. Preferably, a number of folding sticks and an appropriate number of matching elements are disposed adjacent one another and operate *seriatim* during folding.

The invention therefore provides a device which takes up a very reduced amount of space yet which enables it to be folded cleanly; also, a number of folds in a sheet can be made in a single working step substantially simultaneously. Since, conveniently, the arrangement is so deviced that any sheet, whatever its format, has a particular corner applied to stationary abutments and is retained by clamping in this position, the marginal perforation for stapling purposes can be effected simultaneously, a feature which further simplifies the operation.

Preferably, means are provided for selectively adjusting the depth to which the folding sticks penetrate between the matching elements. Conveniently in this case, the sheet to be folded acts by way of appropriate control means to itself select that depth of penetration of the folding sticks which is correct for its format, and to select the associated folding template—which is used to product a diagonal fold facilitating the stapling of the folded sheet. This means that the same device can be used to provide fully mechanised and automatic folding of drawings or folds or different sizes, yet follow the folding pattern specified for each individual format.

These and other advantages of the subject matter of the invention will become apparent from the following description of embodiments, reference being made to the drawings. In the drawings, FIGS. 1–3 illustrate the special folding procedure outlined by German industrial standard DIN 824 which can be performed by the device according to the invention, although the use thereof is not limited just to this particular job. The paper formats to DIN 476 for folding to DIN 824 agree with the recommendations of Committee 6 of the International Federation of the National Standardising Associations—Paper Formats—of August 1934, and these recommendations are supported, according to ISA Bulletin No. 7—Paper Formats—by Belgium, Germany, Finland, Japan, Netherlands, Norway, Austria, Poland, Rumania, Sweden, Switzerland, Czechoslovakia, Hungary and the U.S.S.R. FIGS. 4 to 10 show embodiments of the longitudinal folding device according to the invention, while FIGS. 11–15 show a device which, in an advantageous development of the invention is disposed adjacent the folding sticks and which is for sharp folding and/or cross-folding of sheets which have previously been folded lengthwise.

Specifically:

FIG. 1 illustrates the folding pattern to DIN 824 for the DIN A0 format—i.e. 841 mm. x 1189 mm.;

FIG. 2 illustrates the folding pattern to DIN 824 for the DIN A1 format—i.e. 594 mm. x 841 mm.;

FIG. 3 illustrates the folding pattern to DIN 824 for the DIN A2 format—i.e. 420 mm. x 594 mm.;

FIG. 4 is a side view of the main components of a folding machine according to the invention, the folding sticks being shown in section;

FIG. 5 is another view of the device shown in FIG. 4 after a longitudinal fold has been made, some of the folding sticks having moved in;

FIG. 6 shows another embodiment of a folding machine according to the invention, the view being in section along the line VI—VI of FIG. 7;

FIG. 7 is a section along the line VII—VII in FIG. 6;

FIG. 8 is a view of the folding machine shown in FIG. 6 in section along the line VIII—VIII in FIG. 9, with some of the folding sticks pushed in;

FIG. 9 is a section along the line IX—IX in FIG. 8;

FIG. 10 is a horizontal section along the line X—X in FIG. 8;

FIG. 11 is a section along the line XI—XI in FIG. 13 through a device for the combined sharp folding and transverse folding of sheets which have previously been folded lengthwise;

FIG. 12 is a partial section along the line XII—XII in FIG. 11;

FIG. 13 is a plan view of the device shown in FIG. 11;

FIG. 14 is a section along the line XIV—XIV in FIG. 13, and

FIG. 15 is a view of a clamping device.

FIGS. 1*a*, 2*a* and 3*a* each show the particular format concerned in plan. The chain lines denote folding edges, the distances between them being given near the edges of each figure. Also visible are the positions of the title box, of the stapling perforations in the margin, and of the diagonal folding.

FIGS. 1*b*, 2*b*, 3*b* are perspective views after the longitudinal and diagonal folds have been made, whilst FIGS. 1*c*, 2*c* and 3*c* are views after the transverse folds have been made.

After all these folds have been made the drawing has all the necessary folds to reduce it to the area of the DIN A4 format of 297 mm. x 210 mm., so that it can be placed in a file or the like.

The folding patterns hereinbefore described are relatively complicated to carry out but, if the standard is correctly applied, they are very advantageous so far as rational and practical handling of the sheets or drawings placed in files is concerned. The drawing-folding machine which will be described hereinafter can perform these folds fully automatically although the patterns for the various formats differ considerably from one another in their basic geometric construction. For instance, the diagonal fold is made at a different angle for each format. As a comparison of FIGS. 1, 2 and 3 will show, the between-edges distances for the lengthwise folds are different for each format. The description of the folding patterns mentioned by way of example is intended merely to show the operation of the machine according to the invention which will be described in greater detail hereinafter.

Referring to FIG. 4, moving folding sticks **5–9** are disposed opposite to, but offset from, stationary matching elements **1–4**; the folding sticks **5–9** are adapted to move into the gaps between the elements **1–4**. In FIG. 4 the moving stick **9** has reached a position in which it also is an abutment for the right-hand edge of a sheet of A0 format which has been introduced from the left. In the position shown in FIG. 5, the moving stick **9** is in such a position relatively to its mating or matching element **4** that the sheet to be folded is being clamped tightly between the elements **4** and **9**. This clamping, which is necessary to retain the sheet to be folded, is effected between the elements **8** and **3** in the case of the A1 format and between the elements **7** and **2** in the case of the A2 format. A different clamping is required for the DIN A3 format. Accordingly, a roller **10** is provided which can be moved vertically against a support plate. To fold the A3 format, another moving folding stick **11** is introduced into a gap **12**. To fold the A3 format, all the sticks **5–9** are in their bottom withdrawn position, so that the abutment for A3 sheets is the place **13**. The roller **10** also helps to keep the sheets tight as they are drawn into the gaps between the elements **1–4**.

For the A0 and A1 formats, DIN 824 specifies a penetration depth of 190 mm. each for the sticks **7** and **8**, but the penetration depth for the stick **6** varies with format, being either 109.5 or 125.5 or 192 mm. For the A3 format the stick **11** must move 105 mm. into the gap **12**.

When documents are folded to these spacings, there is, in the case of the DIN A0 to DIN A2 formats, a consistent distance of 210 mm. between the abutment **14** and the stick **1**, and this distance is as specified by DIN 824. For the DIN A3 format the corresponding abutment is at the place **13**, the distance between the same and the abutment **14** being 420 mm. according to DIN 824.

A further development of the device according to the invention will now be described with reference to FIGS. 6–10. Referring to FIG. 6, there can be seen stationary mating elements **1–4**, and moving folding sticks **6–8** can be introduced into the gaps between the stationary elements **1–4** by means of a mechanical linkage, while the stick **5** moves merely as far as the bottom edge of the element **1** and clamps the sheets or drawings in the manner necessary for further folding. Secured to the moving stick **5** are folding templates **15–17** pivotable around their longitudinal axes to extend as far as folding ledges or strips **15***a*, **16***a*, **17***a* secured to the element **1**. The folding templates are used to form the folded-back diagonal fold (cf. FIGS. 1–3). The effect that each template has of folding the sheet upwards is amplified by a folding plate **18** coupled with the templates **15–17** (see FIG. 9). The templates **15–17** and plate **18** are pivoted by magnets **19–22** which operate through toggle mechanisms. The inclined portions of the sheet which have been folded by means of the templates **15–17** and associated ledges **15***a–***17***a* are finish-folded by a pivoted plate **37**; the same is articulated to the stationary element **1** via a lever **49** and is normally kept open by a spring **38**.

The sticks **5–8** are moved vertically by means of mechanical linkages **23–26**. The same, which each comprises a number of levers, are operated by cams **27–30** mounted on a common spindle **31** connected to a driving motor **32**. Since some folding distances must be different for the folding of various formats but others are the same, the corresponding linkages **23–26** must have either fixed pivots (for distances which stay the same) or interchangeable pivot pins (for distances which vary). For instance, the linkage **24** operating the folding stick **5** whose depth of penetration varies with format has interchangeable pivot pins **33–35** whereas, for instance, the linkage **25** has just a fixed pivot pin **36**. The required pivot pin is engaged by means of electromagnets (not shown) before the start of folding when the pivot pins are so disposed in a line, in the manner shown in FIG. 7, that any of them could be introduced into the link element of the linkage system **24** and thereby vary the leverage of at least one of the linkages. In the state of folding shown by way of example in FIG. 9, the pin **35** has been moved into its operative position and the pins **33**, **34** are inoperative.

The pins **33** and **34** can be selectively moved to their individual selective positions to again change the leverage of the linkage and cause the corresponding stick to move upwardly a shorter or greater distance.

The device shown in FIGS. 11–15, which can be attached to a folding machine according to the invention, is used for fully automatic sharp folding and transverse folding. With this device, a sheet which has been folded by the folding sticks and their mating elements and which leaves the folding machine laterally can be pulled out fully, mechanically in the manner indicated at a place **50** in FIG. 10 and folded sharply and, if required, transversely.

The side **53** of the casing in FIG. 12 is that side of the folding machine where abutment ledges or the like **42**, **43** (FIG. 10) are disposed. The side **53** of the casing **54** is formed, in registration with all the moving and stationary stick elements, with apertures **55**, **57** via which the folded sheets can be picked up and pulled out of the machine either by hand or by mechanical grippers (not shown). In this event, the sheet portions which are still not lying completely flat one upon another are guided together through lateral guides **58**, **59** which converge almost to a point, then folded sharply by rolls **60**, **61**. A

special folding effect can be produced, for instance, by resilient rolls. The rolls 60, 61 can cooperate with two folding bars 62, 63 to act as feed rolls which advance the longitudinally folded sheets a desired distance beyond the outside edges of the two folding bars 62, 63, whereafter the sheet is folded transversely. A control mechanism (not shown) rotates the rolls 60, 61 intermittently so that the folded sheet is first moved a distance of 297 mm. beyond the apexes of the folding bars. Before the roll operate again—and before, therefore, the sheet moves again—the same is folded transversely by means known per se. A clamping device 64 which can have rollers 65 (FIG. 15) is moved into the chain-like position 66 visible in FIG. 13 and clamps the previously bent sheet around the apex of the folding bars 62, 63. Either this procedure is repeated, the required spacings being maintained, in dependence upon the number of transverse folds required—something which in turn depends upon the size of the format—or the sharply folded remainder of the longitudinally folded sheet is ejected.

FIG. 14 shows an embodiment of how the clamping device 64 can be rectilinearly guided in its movement parallel with the folding bars 62, 63. Two tubes 68, 69 adapted to move axially parallel with a baseplate 67 are mounted in two bearing lugs 70, 71 thereof. Means known per se drive the rolls 60, 61 and the clamping device 64.

To explain how the folding machine operates, a description will how be given of how a drawing of DIN AO format is folded.

The sheet to be folded is so introduced at a place 39 (see FIGS. 8–10) as to abut the abutments 40–43. A switch (not shown) is operated to start the machine. A magnet-operated perforator produces the marginal perforation 44, 45 in the sheet for stapling purposes. Depending upon the size of the sheet fed in, the switch 46 or 47 or 48 is operated to select the appropriate pivot pin 35 and template 15. The drive 32 then rotates the shaft 31 with the cam thereon. The cams move the various movinbg folding sticks into their corresponding folding position consecutively. First, the stick 5 is raised and clamps the sheet against the matching element 1. As the stick 5 rises, the preselected template 15 secured thereto is pivoted by the magnet 19 as shown in FIGS. 8 and 9. As can be seen in FIG. 8, the folding edge of the template 15 and the corresponding edge of the folding ledge 15*a* are so inclined that that part to be folded of the sheet portion folded up by the template 15 is sharply bent back or folded by more than 90° between the folding edges of the template 15 and the ledge 15*a* once the stick 5 has reached its top position. Because the folding edges are inclined, the template 15 is wedged to the folding ledge, to disengage therefrom only when the stick 5 has withdrawn a little in the manner to be described hereinafter. The construction and operation of the other templates 16, 17 and of the other ledges 16*a*, 17*a* are identical.

The stick 6 is then raised automatically to the extent determined by the preselected pivot pin 35 which has meanwhile been engaged. The linkage 25 now pivots the plate 37 so that the diagonal folding initiated between the folding edges of the template 15 and the ledge 15*a* is completed. Immediately after the stick 6 the sticks 7, 8 are raised very rapidly one after another and move the sheet with them, the same being completely folded around the sticks. The corresponding cam is so devised that the stick 5 has withdrawn as the stick 8 moves in.

Since the folded sheet is under some tension 6–8 which are still in the gaps must be loosened slightly before the sheet is withdrawn. This loosening is also the result of appropriate devising of the cams. The sheet is now drawn through the guide 50 and folded sharply and transversely by the device shown in FIGS. 11–15. Alternatively, the sheet can just be transversely folded around the edges 51, 52 at removal (see FIG. 9).

The other DIN A1 and A2 formats and all the intermediate formats are folded similarly to what has just been described with reference to the folding of DIN A0 format.

By appropriate choice and variation of the cams, any other format can be folded to any other folding pattern. The device according to the invention is therefore a universal device for automatically folding sheets or any other foil-like material.

As a further point, the folding edges of the folding sticks and their mating elements should be rounded, for instance, semicircular, in order not to overstress the sheet.

What I claim is:

1. In a device for folding sheets of paper and the like, comprising a housing having a table adjacent its upper end, said housing being provided with an entrance slot for feeding paper sheets to said housing from said table, stop elements for engaging the edge of said sheets to limit the entrance thereof into said housing, a series of folding bars supported in said housing above said entrance slot and arranged in spaced apart relation, a series of folding bars movable mounted in said casing beneath said entrance slot, one of said movable folding bars being adapted to grip the edge of one of said sheets adjacent the edge engaged by said stop elements and the other of said movable folding bars being arranged to be received between the folding bars supported above said entrance slot in digitating relation therewith, a cam shaft mounted in said housing, a motor for driving said cam shaft, a series of cams on said cam shaft, fulcrum levers pivoted within the housing having one end connected with a corresponding movable folding bar and the opposite end provided with a cam engaging roller, at least one of said fulcrum levers being provided with a series of openings for selectively receiving a fulcrum pin to change the throw of the lever and vary the distance that said at least one folding lever projects between a pair of adjacent folding levers above said entrance slot to thereby vary the spacing of the distance between certain fold lines in the paper sheet.

2. A device as set forth in claim 1 in which said cams are arranged to first cause the paper to be gripped and the remaining folding bars operated thereafter in succession.

3. A device as set forth in claim 1 in which said paper is folded to a predetermined pattern and in which a folding flap is carried by the forwardmost movable folding bar to diagonally fold the corner of said sheet during the folding operation.

4. A device as set forth in claim 1 in which a removable fulcrum pin is provided and selectively received in openings in the fulcrum lever to vary the distance that one of said movable folding bars moves between an adjacent pair of fixed movable bars.

5. A device as set forth in claim 1 in which said cams are disposed on a common shaft.

6. A device as set forth in claim 1 in which the operative edges of the folding bars are rounded.

7. A device as set forth in claim 1 in which the diagonal folding flaps are magnetically operated during operation of the movable folding bars.

References Cited by the Examiner

UNITED STATES PATENTS

1,709,361	4/1929	McCormack	270—85
2,645,044	7/1953	Zimarik	270—85 X
2,699,936	1/1955	Dixon et al.	270—84
3,083,010	3/1963	Salmon et al.	270—80

FOREIGN PATENTS

130,950	3/1901	Germany.

EUGENE R. CAPOZIO, *Primary Examiner.*