July 19, 1960 H. W. HEIN 2,945,529

STRETCH FORMING MACHINE

Original Filed Sept. 30, 1957 2 Sheets-Sheet 1

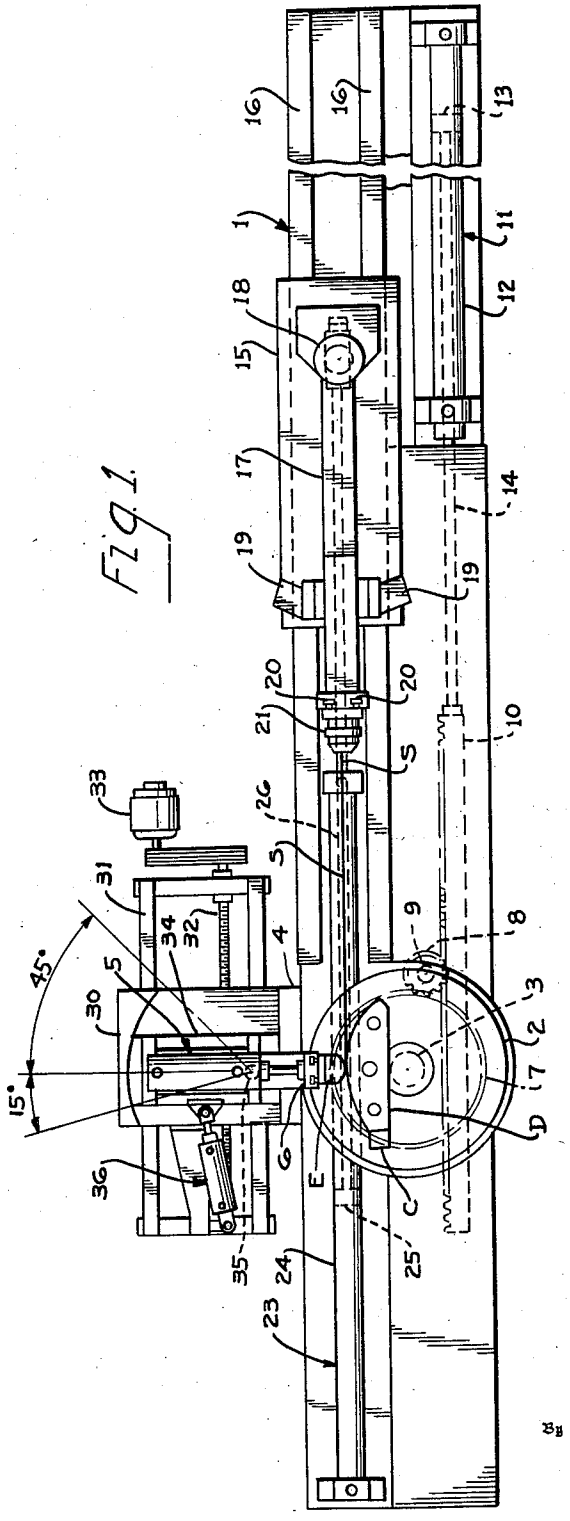


Fig. 1.

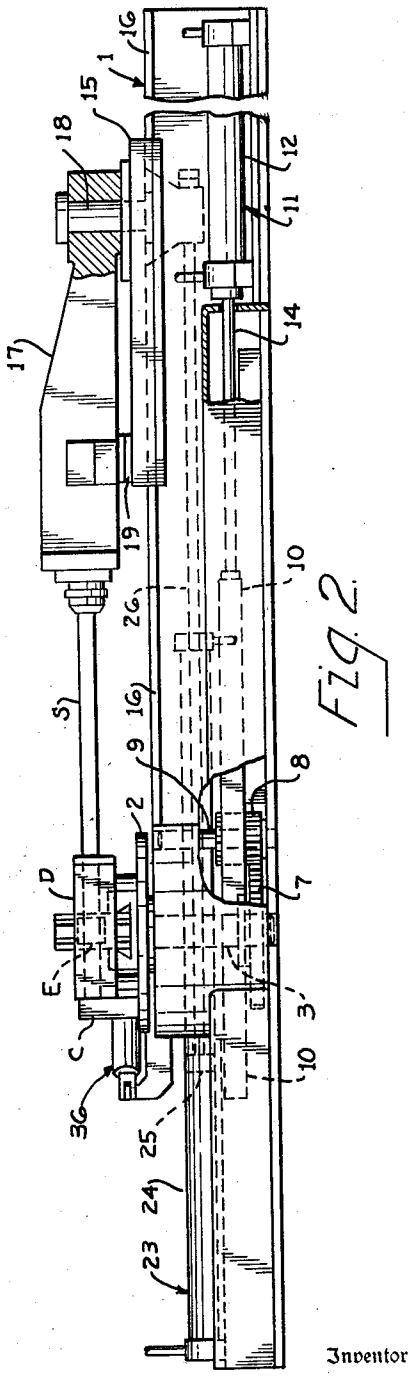


Fig. 2.

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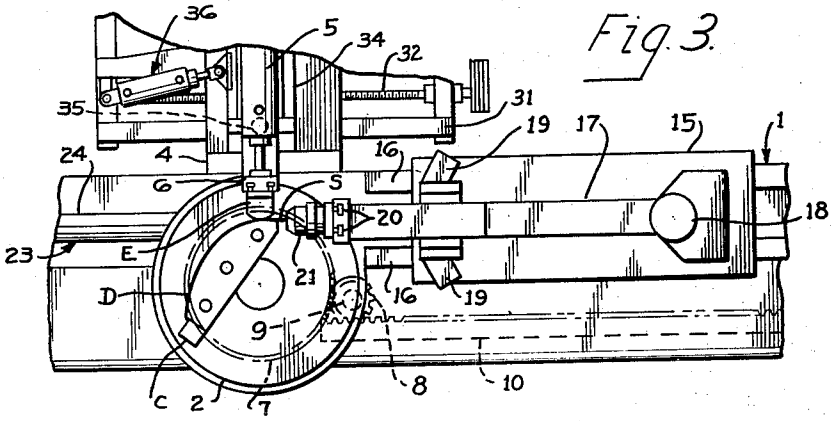
By
his Attorney

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Fig. 3.



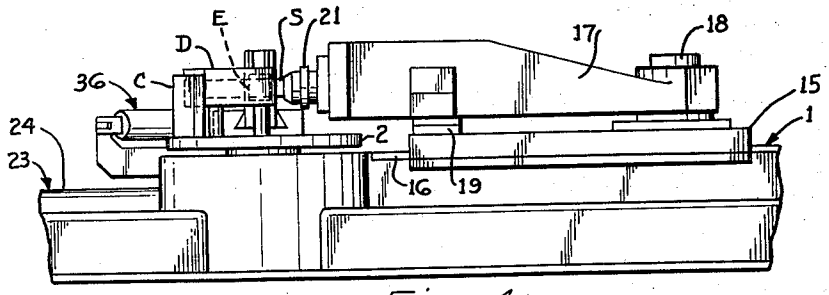


Fig. 4

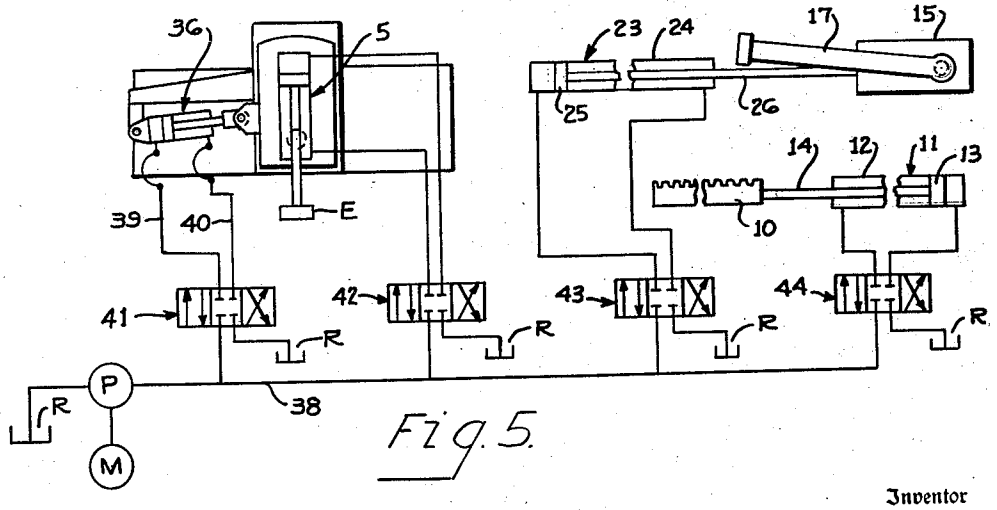


Fig. 5.

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2,945,529

STRETCH FORMING MACHINE

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Continuation of application Ser. No. 687,052, Sept. 30, 1957. This application Sept. 22, 1958, Ser. No. 762,655

4 Claims. (Cl. 153—40)

This invention relates to stretch forming machines for stretch forming of metal about side face dies, and particularly to that type of stretch forming machine in which a length of stock is connected at one end in fixed relation to a side face die while the other end is connected to a suitable tensioning device for applying yieldable tension to the stock endwise thereof as the die and tensioning device are moved relative to each other to wrap the stock onto the side face of the die while the stock is held under said tension.

For purposes of illustration, the present invention is disclosed as embodied in a stretch forming machine of the type generally disclosed in U.S. Patents No. 2,514,830, issued July 11, 1950, to Cyril J. Bath, No. 2,713,376, issued July 19, 1955, to Cyril J. Bath, and No. 2,810,421, issued October 22, 1957, to S. M. Dolney et al., in which machines the die is supported on a turntable which is rotatably mounted on the same frame as that on which a stretch forming piston and cylinder assemblage is mounted, the relative rotation of the die and assemblage being effected by rotation of the table.

The present invention has certain specific advantages over the earlier machines in that the need for swinging the heavy stretch forming assemblage laterally through large angles about an axis parallel to, but offset from, the rotational axis of the turntable is eliminated and the binding stresses occasioned thereby are reduced; the need for traversing the wipe forming assembly endwise of the side face, and for rocking it about an axis parallel to and offset from the table axis, as in Patent 2,810,421, to positions in which more desirable cooperative relations of the assemblages, die and stock are provided, is greatly reduced; the gripped trailing end of the stock can be brought close to the die more effectively at the end of the forming operation; and the instantaneous line of contact of the stock and die resulting from the force applied for tensioning the stock is more nearly coincident with the instantaneous line of contact at which the stock is being pressed against the die by the tool or wipe shoe of the wipe forming assemblage, even with reduced traversing and rocking of the wipe shoe assemblage.

Other objects and advantages of the invention will become apparent from the following description, wherein reference is made to the drawings illustrating a preferred embodiment of the invention, in which:

Fig. 1 is a top plan view of a preferred form of machine embodying the principles of the present invention;

Fig. 2 is a side elevation of the machine illustrated in Fig. 1, part thereof being shown in section;

Figs. 3 and 4 are a fragmentary top plan view and side elevation, respectively, of the machine showing the relation of the wipe forming tool and stretching head at the end of the forming operation; and

Fig. 5 is a diagram of a hydraulic circuit for the machine showing a power supply and control for the machine.

Referring to the drawing, the illustrated embodiment of the machine comprises a frame 1 on which a rotatable

turntable 2 is mounted for rotation about an upright axis 3, all as more fully disclosed in the above identified patent. The turntable supports a side face die D and clamp C for clamping one end of the stock S in fixed position relative to the die D. A lateral frame portion 4 is provided on which is mounted a wipe forming piston and cylinder assemblage 5 having a carriage 6 which carries a wiping or pressure applying tool E which is moved by the piston and cylinder assemblage relatively toward and away from the side face of the die D for pressing the stock S against the side face of the die as it is stretch formed thereagainst. Further, as described in the above identified patent, the table is rotatably driven by means of a suitable main gear 7 mounted on the table in coaxial relation thereto and a cooperating gear 8 which is mounted on the shaft 9 parallel to the axis of the table. The gear 8 is driven by suitable rack 10 which, in turn, is driven by a reversible hydraulic piston and cylinder assemblage, indicated generally at 11, and comprising a cylinder 12 and a piston 13 having a rod 14, the rod being directly connected to the rack 10 for movement therewith. In the form illustrated in Fig. 1, the parts of the machine are in the positions they occupy when the length of stock S is wrapped about half way about the side face of the die D.

It is to be noted that the axis of the piston and cylinder assemblage 11 is offset outwardly from the axis of the turntable 2 and from the shaft 9 and is disposed below the level of the table. The length of the rack 10 is such that the table can be rotated through 360 degrees or 370 degrees so that a complete annular part can be formed after making allowance for the excess stock to be cut off at the ends after formation. This, of course, requires that the outer end of the rack 10, when the assemblage 11 is fully extended, be on the opposite side of a plane through the axis of the table and extending transversely of the frame 1 from the assemblage 11. The frame 1 must extend beyond this plane a distance such that it is beyond the outermost end of the rack 10 when the rack 10 and the piston and cylinder assemblage 11 are fully extended.

The assemblage 11 is supplied with pressure fluid through a conventional reversible valve and from any suitable source so that it is manipulated under the control of the operator.

The tensioning device comprises a carriage 15 mounted on the frame on a guideway 16 which is parallel to, but offset laterally of the frame from, the axis of the assemblage 11. The median line of the guideway is offset laterally of the frame 1 outwardly beyond the axis of the table 2 so as to lie as near as may be to the periphery of the table or the side face of the die at the instantaneous point of contact of the die and the stock.

The carriage 15 is preferably elongated endwise of the guideway 16 and is arranged to be reciprocated along the guideway to a position in which its ends nearest the table can approach very closely the periphery of the table.

Mounted on the carriage 15 for swinging about an axis parallel to, and offset from, the axis of the table is an elongated arm 17 which is relatively light weight compared to the weight of the stretch forming piston and cylinder assemblage. The arm 17 is pivotally connected to the carriage 15 near the end of the carriage remote from the table by a pivot 18 and extends back in overhanging relation to the carriage a distance sufficient to project endwise beyond the end of the carriage nearest the table when the arm is aligned endwise of the guideways with the carriage. As best illustrated in Fig. 2, the free end of the arm 17 extends sufficiently beyond the end of the carriage 15 nearest the table so that, when that end of the carriage is substantially at the periphery of the table, the free end of the arm lies in

spaced face to face relation to the die supporting face of the table at a point on the opposite side of the center of the table from the carriage 15. Thus, assuming the table is horizontal, the free end of the arm 17 can swing in a path overhanging the top surface of the table. The arm 17 and the carriage 15 are provided with complementary skid bearing members 19 which are preferably arranged as near as may be to the end of the carriage 15 nearest the table. These bearing members engage each other and thus support the arm against flexure in a direction toward and away from the plane of the table.

At its outer or free end, the arm 17 is provided with means in the form of T-slots 20 by which it is connected to a stock gripping head 21 which, in turn, is arranged to grip one end of the stock for exerting tension thereon.

In order to urge the carriage yieldably away from the table 2, a stretch forming piston and cylinder assemblage 23 is provided. The piston and cylinder assemblage 23 includes a cylinder 24 having therein a piston 25 with a piston rod 26, the piston rod being connected to the carriage 15 for movement therewith. The piston and cylinder assemblage 23 is preferably so arranged that, when the carriage 15 is at the closest point of approach to the table 2, the piston and cylinder assemblage 23 is fully retracted. However, the stroke required for moving the carriage 15 the full distance required for the particular machine is considerable and, accordingly, advantage is taken of the fact that a length of the frame 1 is provided at the opposite side of a plane through the axis of the table and extending transversely of the frame from the table driving assemblage 11. One end of the assemblage 23 is placed at the outermost end of the frame portion 1 and the assemblage then extends back toward and beneath the table, across said plane, to its point of connection to the carriage 15. In order to provide as long a stroke as possible, useful for stretch forming, the piston rod 26 is connected to the carriage 15 at the end farthest from the periphery of the table. The piston and cylinder assemblage 23 is preferably a reversible hydraulic assemblage and is connected to a suitable source of power and sump through a conventional reversible valve which may be operated at the instance of the operator.

Thus, the full advantage is taken of the overall length of the total frame of the machine. At the same time, abrupt angles between the tangent at the instantaneous point of contact of the stock with the side face die, extending through the point of connection of the stock engaging means with the carriage 15 which is at the pivotal axis 18, and a plane through said axis and parallel to the piston rod 26, are eliminated.

This arrangement has an advantage in that binding stresses due to the abrupt angularity of axis of the stretch forming assemblage relative to the length of the frame is greatly reduced, even when the carriage is close to the table. Furthermore, there is a compensating factor in that ordinarily the binding stresses in a piston and cylinder assemblage are greatest when the assemblage is fully extended. With the present arrangement, the angularity of the arm 17 relative to the guideway 16 is least when the carriage 15 is farthest removed from the table. Consequently, the binding stresses due to angularity are reduced when the binding stresses due to extension of the assemblage 23 and assemblage 11 are the greatest. On the other hand, as the carriage 15 approaches the table, the stresses due to angularity are increased but those due to extension of the piston and cylinder assemblages 23 and 11 are decreased, so that there are more nearly uniform stresses and frictional binding forces throughout the entire operation.

Due to the length of the arm 17 and its pivotal connection with the carriage 15 at a point remote from the table, the angle of the stock with an upright plane through the axis 18 and parallel to the guideway 16 is not very abrupt even when the carriage 15 is moved to its nearest position relative to the table. Also, the arm is relieved from the severe stresses of overhang due to the cooperable bearings 19. The arm overhangs the table sufficiently so that the gripped end of the stock can be moved to and fro over the upper surface of the table almost to diametrically opposite sides thereof during the forming operation.

By arranging the piston and cylinder assemblage 23 so that it extends to one side of the axis of the table, endwise of the frame, beyond the other side, there is an overall saving in the length of the machine equal to the distance between the axis 18, the point of pivotal connection of the arm 17 with the carriage 15, and a vertical plane through the axis of the table 2 extending transversely of the frame. The length which is sacrificed for accommodating the rack 10 in its fully extended position is offset against part of the total length required for the piston and cylinder assemblage 23 when the assemblage 23 is fully extended.

In the prior machines such as illustrated in Figs. 11 and 12 of the above Patent No. 2,713,376, the stretch forming head and its support are pivotally mounted on a carriage which travels along a path which intersects the table axis and extends endwise of the machine at right angles to the axis of the wipe forming assemblage. The travel of the carriage toward the table is resisted by a stretch forming assemblage on the frame. If desired, as there shown, another stretch forming assemblage may be mounted on the carriage and connected to the head.

However, due to the fact that the carriage path extends through the table axis at all times, the line of pull on the stock is angularly disposed to the carriage path, sloping from the instantaneous line of contact of the stock with the die inwardly of the table toward said path in a direction endwise of the path away from the table. As a result, the instantaneous line of contact of the stock and die resulting from the tensioning force applied by the stretch forming assemblage and the coexisting instantaneous line of contact resulting from the stock being pressed against the die by the tool E of the wipe forming assemblage, are not approximately coincident with each other.

Instead, the instantaneous line of contact of the stock and die due to the stretching force, is spaced from the instantaneous line of contact due to wipe forming, in a direction circumferentially of the table opposite to the direction of rotation of the table, thus disposing the line of contact due to stretching nearer to the stretch forming head than is the line of contact resulting due to wipe forming. The closer the stretch forming head approaches the table, the greater is the angle and, consequently, the farther the stretch forming line of contact migrates circumferentially of the table, away from the wipe forming line of contact.

By offsetting the path of the carriage 15 and the axis 18 of the arm 17 in the manner hereinbefore described, the two coexisting instantaneous lines of contact can be made more nearly coincident.

As more fully described in the above Patent 2,810,421, provision is made for traversing the wipe shoe assemblage and for rocking it about an upright axis. One purpose of these traversing and rocking movements is to cause the said two coexisting instantaneous lines of contact to be more nearly coincident. Oftimes a relatively long traversing path and frame, and a large rocking angle are required for this purpose. As a result, the extension of the assemblage and overhang of the parts thereof becomes so large as to present a serious problem. Such a mounting for the wipe forming shoe is illustrated here, the assemblage 5 and carriage 6 being mounted on the base 30 which is slidable along a trackway 31 and is driven therealong by a suitable feed screw 32 which, in turn, is driven by a reversible electric motor 33. The assemblage 5 and its carriage 6 are carried on a swivelling supporting plate 34 which is mounted on the base 30

for swinging about an upright pivot 35 through an angle of 15° in one direction from its normal position to 45° in the opposite direction. A reversible hydraulic piston and cylinder assemblage 36 is pivotally connected at one end to base 30 and pivotally connected at the other end to the plate 34 and is operable for swinging the assemblage 5 about the pivot 35.

As mentioned, these traversing and rocking movements can be greatly reduced and, in many cases, entirely eliminated, by offsetting the path of the carriage 6, from the position shown in the above patents wherein it intersects the table axis, in a direction transversely of its path toward the wipe forming assemblage.

In this connection, it is desirable, for effective wipe forming to mount the die D on the table so that the travel of its side face endwise, as distinguished from the travel of its side face flatwise, is at right angles to a vertical plane through the axis of the assemblage 5 for each increment of the side face as that increment passes into and out of contact with the wipe forming shoe E. However, this endwise travel of a die face often necessitates mounting of the die with its side face nearer the periphery of the table than the axis of the table, and with its side face extending as near as may be circumferentially of the table. Mounting the dies near the periphery also greatly reduces the extension and overhang of the wipe assemblage 45. These factors tend to fix the instantaneous line of contact of the stock and the die, due to the wipe shoe, within a limited range of positions circumferentially of the table axis. By offsetting the path of the carriage 15 and the pivot 18 from the axis of the table in the direction toward the wipe forming assemblage, the instantaneous line of contact of the stock due to the pull exerted by the head is shifted circumferentially of the table in the direction of rotation of the table at the side near the wipe forming assemblage so that it is brought closer to, and approximately coincident with, the instantaneous line of contact of the stock and die caused by the wipe forming shoe.

Generally, the instantaneous line of contact due to stretch forming is between or very closely adjacent the leading and trailing limits of the tool in a direction of endwise travel of the stock past the tool so long as the pivot about which the stretch forming head swings is a considerable distance from the table.

The use of an elongated stretch head supporting member, such as the arm 17, so that the pivot 18 is far removed from the head 21, assists in reducing the angle through which the head must swing for a given travel of the head transversely of the machine, thus keeping the instantaneous lines of contact more nearly coincident, as obviously the more abruptly the arm 17 slopes toward the longitudinal median line of the frame 1 in a direction away from the table, the farther is the instantaneous line of contact of the stock and die due to the tensioning force caused to migrate about the die opposite to the direction of table rotation.

A number of hydraulic systems can be used to operate the machine. A basic and simple manual system is illustrated in Fig. 5, wherein operating pressure fluid is supplied by a pump P driven by a motor M. A main feed or manifold line 38 leads from the output side of the pump P. The inlet side of the pump is connected to a common sump R. The opposite ends of the cylinder of the assemblage 36 are connected by lines 39 and 40 to a reversing valve 41, diagrammatically illustrated, which is connected to the line 38 and to the sump R and so arranged that it can connect either end of the cylinder of the assemblage 36 to the line 38 and concurrently connect the other end to the sump R. In an intermediate position, the valve 41 hydraulically locks the assemblage 36 in fixed positions.

Correspondingly, the assemblages 5, 11, and 23 are connected to the line 38 and the common sump R by similar reversing valves 42, 43 and 44, respectively.

Thus each assemblage can be operated in such relation to the operations of the others as are selected for a particular forming operation.

In the present description, the machine has been described as though operating with a table having an upright axis. This is for convenience in defining the relative positions of the parts, as obviously the machine can be operated equally as well were it disposed with the table axis horizontal or in some other position than upright, and the terms "upright" and "horizontal," as used in the description and in the claims, are not meant to limit the structure to such terms as absolutes but only to describe the relative position of the parts.

This application is a continuation of my copending application Serial No. 687,052, filed September 30, 1957, and entitled Stretch Forming Machine, and now abandoned.

Having thus described my invention, I claim:

1. In a stretch forming machine comprising a horizontal frame, a table mounted thereon for rotation about a predetermined upright axis, power driving means for rotatably driving the table, a side face die and a means for securing one end of a length of stock in fixed position relative to the die, said securing means and die being mounted on the table with the side face of the die generally upright, said die face being curvilinear about said upright axis, a guideway in fixed position on the frame, a carriage mounted on the frame for movement freely in opposite directions, independently of operation of the table driving means, along said guideway in a predetermined horizontal path extending generally endwise of the frame toward and away from the table, connecting means on the carriage including a stock gripping head connectible to the stock for applying tension to the stock when the carriage is urged along said path in a direction away from the table, an elongated fluid pressure operated stretch forming piston and cylinder assemblage including a piston member and a cylinder member and operatively disassociated from the driving means, one of said members being connected to the carriage with its axis parallel to said path, and the other of the members being connected to the frame for yieldably urging the carriage away from the table during the travel of the carriage along said path, means to supply yieldable fluid pressure to said assemblage for yieldably urging the carriage away from the table, a wipe forming assemblage mounted on the frame, a pressure applying tool mounted on the wipe forming assemblage and movable thereby, in one position of the wipe forming assemblage, along a horizontal path extending substantially through the table axis and at substantially a right angle to the direction of the carriage path, into wipe forming engagement with stock on the die face, power means to operate the wipe forming assemblage in the tool applying direction, said power driving means being operable for rotatably driving the table in a direction of rotation wherein the periphery of the table adjacent the wipe forming assemblage moves in a direction away from the carriage, said connecting means including an elongated arm connected near one of its ends to the carriage for swivelling about a pivotal axis parallel to said predetermined upright axis and said arm extending from its pivoted end back toward the table in overhanging relation to the carriage and normally parallel to the carriage path, said stock gripping head being connected to the arm near the other end of the arm, and said guideway and pivotal axis being offset in a direction transversely of the guideway from said predetermined upright axis in a direction toward the wipe forming assemblage whereby the instantaneous line of contact of the stock and die resulting from the force applied by the stretch forming assemblage is positioned, circumferentially of the table, approximately at the instantaneous line of contact at which the stock is being pressed against the die by said

tool while the arm is parallel to the carriage path, and the wipe forming assemblage is in said one position.

2. The structure according to claim 1 wherein the axis of the stretch forming piston and cylinder assemblage, the path of said carriage, and the line of pull of the head are nearer to the periphery of the table than to said predetermined upright axis.

3. A structure according to claim 1 wherein the member of the stretch forming assemblage which is connected to the carriage is connected thereto at the end portion of the carriage nearest the pivotal connection of the arm and carriage.

4. In a stretch forming machine comprising a horizontal frame, a table mounted thereon for rotation about a predetermined upright axis, a side face die on the table, a means for securing one end of a length of stock in fixed position relative to the die, a guideway in fixed position on the frame, an elongated carriage mounted on the frame for movement along said guideway in a predetermined horizontal path extending generally endwise of the frame toward and away from the table, connecting means on the carriage including a stock gripping head connectible to the stock for applying tension to the stock when the carriage is urged in a direction away from the table, stretch forming power means connected to the carriage for urging the carriage away from the table during the travel of the carriage along said path, means operatively disassociated from the stretch forming power means for rotatably driving the table, and said connecting means including an elongated rigid arm pivotally connected near one of its ends to the carriage for swinging about an upright pivotal axis, said arm extending from said pivotal axis back, over the carriage, toward the table, complementary bearing means on the carriage and arm engaging each other and spaced from said end of the arm toward the other end of the arm, and the stock gripping head being carried at said other end of the arm.

References Cited in the file of this patent

UNITED STATES PATENTS

2,514,831	Bath	July 11, 1950
2,536,738	Green	Jan. 2, 1951
2,734,548	Fredricks	Feb. 14, 1956
2,806,506	Yurka	Sept. 17, 1957
2,810,421	Dolney et al.	Oct. 22, 1957