STRETCH FORMING MACHINE WITH TROLLEY
SUPPLIED POWER UNIT ON STRETCH CARRIAGE

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This invention relates to an improvement in stretch forming machines of the general character disclosed in
United States Letters Patent No. 2,514,830, issued July
11, 1950, to Cyril J. Bath, and particularly to a new oper-
ating connection between the stretch forming piston and
cylinder assembly and the stock engaging stretching head wherein the usual long and complicated flexible
hoses and the like for supplying the hydraulic pressure
fluid to the stretch forming assemblage and to other
hydraulically operated mechanisms associated with the
stretching head, and also long flexible cables for carrying
electric power and control currents to various controls
associated with the stretching head, are eliminated.

A more specific feature of the invention resides in the
fact that the pump and motor for supplying hydraulic
power for operating some mechanisms of the stretch forming assemblage are carried on the carriage by which
the stretch forming head is carried toward and away
from the side face die, and electric power and control
currents supplied to mechanisms on the carriage are sup-
plied thereto principally through suitable trolley mecha-
nisms, whereby the usual long flexible hoses leading from
a central pump on the machine frame and long flexible
electric cables, are unnecessary.

Another feature is to provide a stretch forming ma-
chine, including a side face die support, wherein the
stretch forming head is carried on a carriage which is
movable relatively toward and away from the die sup-
port, along a track or guideway, a hydraulic cylinder ex-
pects endwise of the track and is movable with the car-
rriage, a double-ended piston is reciprocable in the cylin-
der and has its ends connected in fixed relation to the
track so that the hydraulic forces applied to the piston
for urging the carriage in opposite directions, maintain
the piston rod in tension. This arrangement of the piston
and cylinder assemblage also affords other advantages
in cases of machines in which the carriage must travel
along distances in a direction toward and away from the
die support.

Another feature resides in the manner of connecting
the cylinder to the carriage for travel therewith and for
relieving the cylinder from excessive strains due to the
weight and long overhang.

Another object is to provide a trolley system for elec-
tric control currents for the mechanisms on the travel-
carring carriage, whereby effective remote control can
be obtained.

Other objects and advantages of the invention will be-
come apparent from the following description wherein
reference is made to the drawings, in which:

FIG. 1 is a top plan view of a stretch forming machine
embodifying the principles of the present invention and
including a hydraulic power diagram;

FIG. 2 is a front elevation of the machine illustrated
in FIG. 1;
type so that it can be operated from a point remote from the head to grip or release the stock, as will later be described. The arm 33 is elongated so as to be suitable for use with an elongated load cell, as more fully described in the appended applications of Perkins and De Marco, Serial No. 858,376, filed December 9, 1959, and executed November 23 and December 5, 1959, and in the above United States Letters Patent No. 2,514,830. The jaws of the stock 37 on the carriage for supporting part of the overhanging weight of the arm on, and relieving the arm from, vertically directed flexure stresses. In order to reciprocate the carriage 20 so as to apply yieldable stretch forming tension to the stock to be formed as it is wrapped about a side face forming die D on the table 2, a suitable cylinder 40 is provided. The cylinder 40 extends endwise of the tracks 23 and 24 and is secured to the carriage 20 for movement therewith endwise along the tracks in endwise fixed relation to the carriage. However, since the stresses and forces on the carriage may tend to cause rocking movement of the carriage and deflection thereof vertically and transversely of the tracks, the cylinder 40 is connected to the carriage by a swivel connection so that it can maintain its proper position in axial alignment with its starting position during reciprocation of the carriage. For this purpose, a bracket 42 is fixedly secured to the cylinder 40 near one end of the cylinder. The bracket 42 is pivotally connected to a link 43 in a conventional manner for rocking relative thereto about a horizontal axis, as illustrated in Fig. 2. The other end of the link is correspondingly pivotally connected to a securing bracket 34 on the carriage. The link is a conventional swivel link, thus allowing the slight rocking of the carriage about the axis of the cylinder, in addition to vertical movement of the cylinder relative to the carriage. To relieve the carriage of the weight of the cylinder and the cylinder from deflecting forces due to its own weight, the cylinder, at the end farther from the table in the retracted position of the carriage 20, is connected to, and rests on, a suitable saddle 50 having rollers 51 which roll along the track 24. At its opposite end which is nearer to the table in the retracted position of the carriage, the cylinder is provided with a sliding roller 53 which is arranged to roll on a track 54 which extends part way lengthwise of the frame 1 parallel to the tracks 23 and 24. Thus the opposite ends of the cylinder 40 are supported suitably and anti-frictionally on trackways so that the cylinder is relieved from any excessive vertical deflection stresses resulting from its weight. Mounted in the cylinder is a double-end piston 56 having oppositely extending hollow rods 57 and 58. The rods 57 and 58 have ports 57a and 58a adjacent to the opposite sides, respectively, of the piston 56 for communicating the interiors of the rods with the interior of the cylinder 40. The rods 57 and 58 are fixedly connected to the ends of the frame of the machine and are connected to rigid fluid pressure supply pipes 59 and 60, respectively. Thus, by admission of pressure fluid to one side of the piston 56 in the cylinder 40, the carriage is urged away from the table and, by admission of pressure fluid to the opposite side of the piston, the carriage is urged toward the table. The forming of the stock is occasioned by gripping one end of the length of stock 35 in the conventional hydraulically operated jaws of the stretch forming head 35, and the other end in a suitable clamp 61 which is mounted on the table 2 for rotation therewith in fixed relation to the die D. The stretch forming operation is performed in essentially the manner described in the above United States Letters Patent No. 2,514,830. The jaws of the head 35 are manipulated by a hydraulic piston and cylinder assembly 62 mounted on the head 35. In order to supply pressure fluid to the assembly 62, a variable delivery hydraulic pump 64 and its electric driving motor 65 are mounted on the carriage 20 in fixed position relative to the arm 33 for swinging therewith. A pump tank 66 for the pump and hydraulic circuit is mounted on the carriage 20. By this arrangement, the pump can be connected by rigidly fixed pipes 67 and 68 to opposite ends of the cylinder 62, respectively, the pump being connected to these lines through a conventional remotely controlled reversing control valve 69, later to be described. Long flexible pressure fluid conduits and hoses are eliminated. If, as in U.S. Patent No. 2,806,505, issued September 17, 1957, it is desired to raise and lower the stretch head by a hydraulic assemblage, or any other mechanisms on the arm 33 to be operated hydraulically, direct connections may be made thereto from the pump 64. The motor 65 is an electric motor and a number of the controls utilized in connection with the carriage and the stretch forming mechanisms thereon are electric. Accordingly, it is necessary to supply electric power and control currents to the mechanisms on the carriage. For this purpose, suitable track supports 70 and 71 are mounted on a frame member 13 at a location below the carriage 20. The track support 70 carries suitable tracks 72, and the track support 71 carries a suitable track 73. Trolley 74 are arranged to operate on the tracks 72, respectively, and are connected by suitable electric cables encased in a conduit 76 to the various mechanisms on the carriage. The main motor 65 employs a much higher voltage and, therefore, is connected by a separate cable to a trolley 78 which operates on the track 73. The tracks 72 and 73 are held in fixed position end-wise of the frame. Since all of the tracks and trolleys are the same, except for size, in form and function, only one will be described in detail. As illustrated in Fig. 5, each track 72 comprises in general an inverted housing 80 open at the bottom and having at the bottom two interlaced flanges extending inwardly toward each other and terminating in spaced relation to each other transversely of the housing 80. These flanges provide tracks 81. Each trolley comprises a housing 82 having supporting wheels 83 operating on the tracks 81, and a centering and guide wheel 84 for maintaining the trolley in proper position laterally for endwise travel along the tracks 81. Each housing 80 carries three bus bars 85 and each trolley carries three pairs of contacts 86 arranged so that the pairs operate along the bus bars 85, one pair to each bus bar, respectively. The trolleys, as mentioned, are connected through the rigid conduit 76 for movement with the carriage 20 as the carriage moves along its supporting trackways 23 and 24. Thus, there are means for providing electrical connections at all times between those mechanisms carried on the carriage and the central control panel through the media of a fixed cable on the carriage, the trolleys, and the bus bars 85. Referring to Fig. 7, the motor 65 is connected through suitable leads to the trolley 78, the bus bars for which are connected to a source of power, indicated by lines L1 and L2, by way of a control panel 88, through a suitable switch 89. Thus, through the switch 89 and the trolley 78, and its bus bars, the motor M can be started and stopped. As mentioned, the pump 64 preferably is a variable displacement pump so that discharge may be controlled directly by an electrically operable control 90. If it is desired to control the pump 64 from the panel 88, this may be done by a suitable control device 91 mounted in the panel and electrically connected to the control 90 through one of the bus bars of one of the trolleys 72. Again, the valve 69 for the jaw cylinder 62 can be operated by suitable solenoids 93 which are controllable by
a suitable control device 94 in the control panel to which the solenoids are connected electrically, respectively, through others of the bus bars and their trolleys 72.

The control of the stretch forming piston and cylinder assembly is illustrated diagrammatically in FIG. 8. As illustrated, the lines 59 and 60 are connected to a three position, four-way valve 95, which may be operated remotely by suitable solenoid controlled piston and cylinder assemblies 96, or manually, if desired. Pressure fluid is supplied to the valve 95 from a pump 97 driven by a motor 98, the pressure being controlled by a suitable relief valve 99.

The valve 95 operates in one position to admit pressure fluid to the cylinder at one side of the piston 56 through the rod 57 and vent the cylinder at the opposite face of the piston 56 through the rod 58, and in another position to reverse the connection.

This makes possible both the movement and the resistance to movement of the carriage 28 by the piston 56 in a manner such that, at all times, the hydraulic force acts through a piston rod under tension. In no case are the piston rods placed under compression and hence the piston and cylinder assembly is not subjected to compressive forces which would tend to cause a column effect, such as buckling and binding of the assembly.

In the prior structures in which the cylinder was carried on the carriage so as to eliminate this buckling effect, considerable difficulty was encountered in case of very long pieces to be formed. This was because the movement of the cylinder of the carriage was considerable in utilizing the use of long flexible hoses for conducting pressure fluid from the source to the opposite ends of the cylinder. Such hoses impose a considerable problem inasmuch as, for a given pressure delivered by the pump, the pressure delivered by the hoses varies depending upon their degree of flexure and sharpness of bend. The bending and flexing of the hoses necessarily introduces variations in the flow of the hydraulic pressure fluid. The variables introduced by long flexible hoses in the pressure line are often unpredictable and inconsistent.

By combining the mounting of the cylinder on the carriage and introducing the pressure fluid through the ends of a double-ended piston connected to the frame, the flow characteristics into the cylinder at either side of the piston can be kept constant regardless of the position of the cylinder and carriage along the path of travel of the carriage. This greatly facilitates the control of the tensioning of the stock and, since a number of variable factors must be taken into consideration in controlling the tension applied to the stock, the elimination of variables arising from the piston and cylinder assembly itself and from a flexible hose fluid supply circuit, contributes greatly to simplification of control of the fewer variable factors remaining.

By mounting on the carriage the fluid pressure supply for operating those things carried on the carriage and particularly by mounting the fluid pressure supply on the carriage through the medium of the pivoted support for the arm 33 so that it swings with, and in fixed position relative to, the arm 33, additional stresses are eliminated, as rigid, short, and fixed pipes are used instead of long flexible hoses which latter must be flexed continuously during different degrees of the travel of the carriage and swinging of the arm 33.

The placing of the stretch forming piston and cylinder assembly connections between lines of stock under tension and at times under compression further eliminates variable friction and binding stress which would be continuously changing and would have to be compensated for, thereby further complicating control of the tension applied to the stock.

If the tension control is desired, it may be effected as disclosed in U.S. Patent No. 2,849,048, issued August 26, 1958, in response to a load cell 100 having a strain gauge 101 connected to a suitable amplifying tension signal control unit 102 on the carriage which receives and amplifies electrical tension signals from the strain gauge 101. These signals, after amplification, are carried by another one of the trolleys 72 and one of its bus bars to a suitable control device on the control panel 88.

It is to be pointed out that the specific mechanisms on the carriage to be controlled depend on the work to be performed and may vary without departing from the concepts of the present invention which reside primarily in the manner of supplying the pressure fluid to the stretch forming assembly, the manner of providing on the carriage the pump and the motor so as to eliminate long flexible pressure conduits for operating mechanisms on the carriage, and the provision of a means for supplying electric power, control currents, and signals to various mechanisms on the carriage through the introduction of guarded trolley and bus bars.

Having thus described my invention, I claim:

1. In a stretch forming machine, a frame, a power driven turntable rotatably mounted thereon and adapted to support a side face die, a stretch forming carriage mounted on the frame for movement toward and away from the table, a stretch forming head adapted for connection to an end of a length of stock for applying tension to the stock endwise for stretch forming it about the die, means connecting the head and carriage for movement together toward and away from the turntable, power means for controlling the movement of the carriage toward the table, clamp means for connecting the stock, at a location spaced from said end, for movement with the table, a hydraulic pump on the carriage, an electric motor on the carriage operable for driving the pump, hydraulic motor means connected to the head for effecting a predetermined operation of the head, hydraulic circuit means on the carriage and connecting the pump to the hydraulic motor means for operating the hydraulic motor means, conductor means for supplying electric power to the electric motor, said conductor means including a trolley movable with the carriage and electrically connected to the motor, and trolley line means connecting the trolley to a source of electrical power.

2. In a stretch forming machine, a frame, a power driven turntable rotatably mounted thereon and adapted to support a side face die, a stretch forming carriage mounted on the frame for movement toward and away from the table, a stretch forming head adapted for connection to an end of a length of stock for applying tension to the stock endwise for stretch forming it about the die, connecting means connecting the head and carriage for movement together toward and away from the turntable, power means for controlling the movement of the carriage toward the table, clamp means for connecting the stock, at a location spaced from said end, for movement with the table, a hydraulic pump on the carriage, an electric motor on the carriage operable for driving the pump, hydraulic motor means connected to the head for effecting a predetermined operation of the head, hydraulic circuit means on the carriage and connecting the pump to the hydraulic motor means for operating the hydraulic motor means, conductor means for supplying electric power to the electric motor, said conductor means including a trolley movable with the carriage and electrically connected to the motor, and trolley line means connecting the trolley to a source of electrical power.

3. In a stretch forming machine, a frame, a power driven turntable rotatably mounted thereon and adapted to support a side face die, a stretch forming carriage mounted on the frame for movement toward and away from the table, a stretch forming head adapted for connection to an end of a length of stock for applying tension to the stock endwise for stretch forming it about the die,
means connecting the head and carriage for movement together toward and away from the turntable, power means for controlling the movement of the carriage toward the table, clamp means for connecting the stock, at a location spaced from said end, for movement with the table, a hydraulic pump on the carriage, an electric motor on the carriage operable for driving the pump, hydraulic motor means connected to the head for effecting a predetermined operation of the head, hydraulic circuit means on the carriage and connecting the pump to the hydraulic motor means for operating the hydraulic motor means, conductor means for supplying electric power to the electric motor, an electric control means being carried on the carriage for controlling a mechanism on the carriage, a trolley movable with the carriage and electrically connected to the control means, and trolley line means connecting the trolley to a source of control power.

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