United States Patent

Cintract et al.

[15] **3,682,259**

[45] **Aug. 8, 1972**

[54] **ROD STACKING AND HANDLING APPARATUS**

[72] Inventors: **Bernard G. Cintract,** 2 Place des Ecoles, Boulogne 92; **Rene G. Sevin,** 6 rue Pierra Ronsard, 95 Garges-les-Gonesse, both of France

[22] Filed: **April 13, 1970**

[21] Appl. No.: **27,930**

[30] **Foreign Application Priority Data**

Jan. 9, 1970 France.......................7000681

[52] **U.S. Cl.** **175/85,** 214/2.5, 254/139

[51] **Int. Cl.**..**F21b 19/00**

[58] **Field of Search** 175/85, 5, 7, 8, 10; 214/2.5; 254/139

[56] **References Cited**

UNITED STATES PATENTS

3,280,920	10/1966	Scott	214/2.5
2,643,005	6/1953	Jarnett	214/2.5
2,692,059	10/1954	Bolling, Jr.	175/85
R 26,284	10/1967	O'Neill et al.	175/85
2,187,392	1/1940	Chappell	214/2.5
3,061,011	10/1962	Paget	175/85
3,177,944	4/1965	Knights	175/85

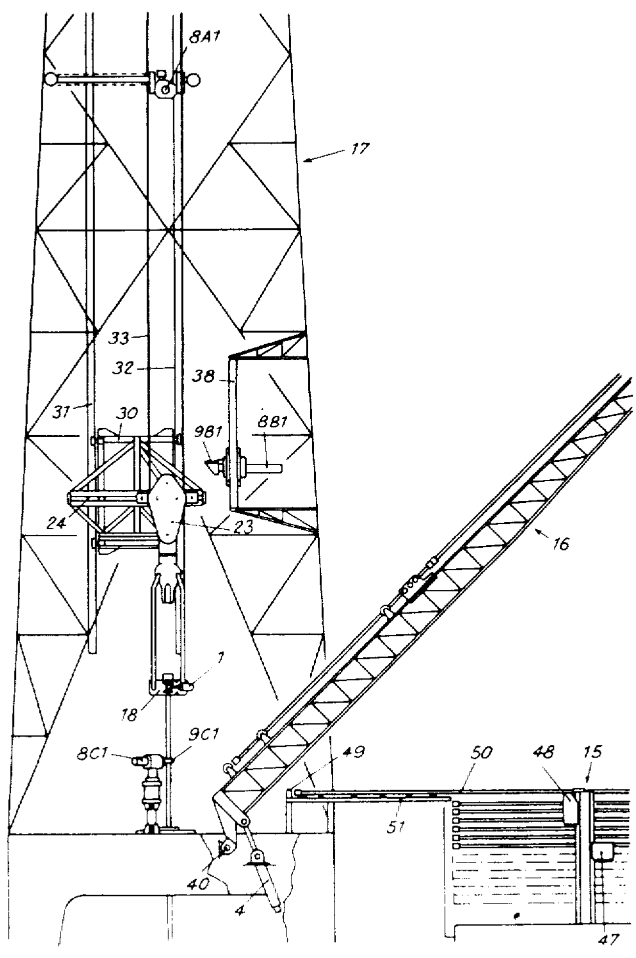
Primary Examiner—James A. Leppink

Attorney—Sughrue, Rothwell, Mion, Zinn & Macpeak

[57] **ABSTRACT**

Stacking and handling apparatus for drilling rods or tubular elements, comprising a girder pivotable about a horizontal axis between a horizontal position wherein it is adapted to pick up a horizontal rod or tubular element at a storage station, and a vertical position wherein it is adapted to align said rod with the drilling axis of a derrick. Both the girder and the derrick are provided with rod or tubular element gripping and moving assemblies. Control means are provided for the girder, the derrick and their assemblies, and a switching circuit is provided to connect said control means and to control the movement of the girder, the derrick and their assemblies.

10 Claims, 20 Drawing Figures



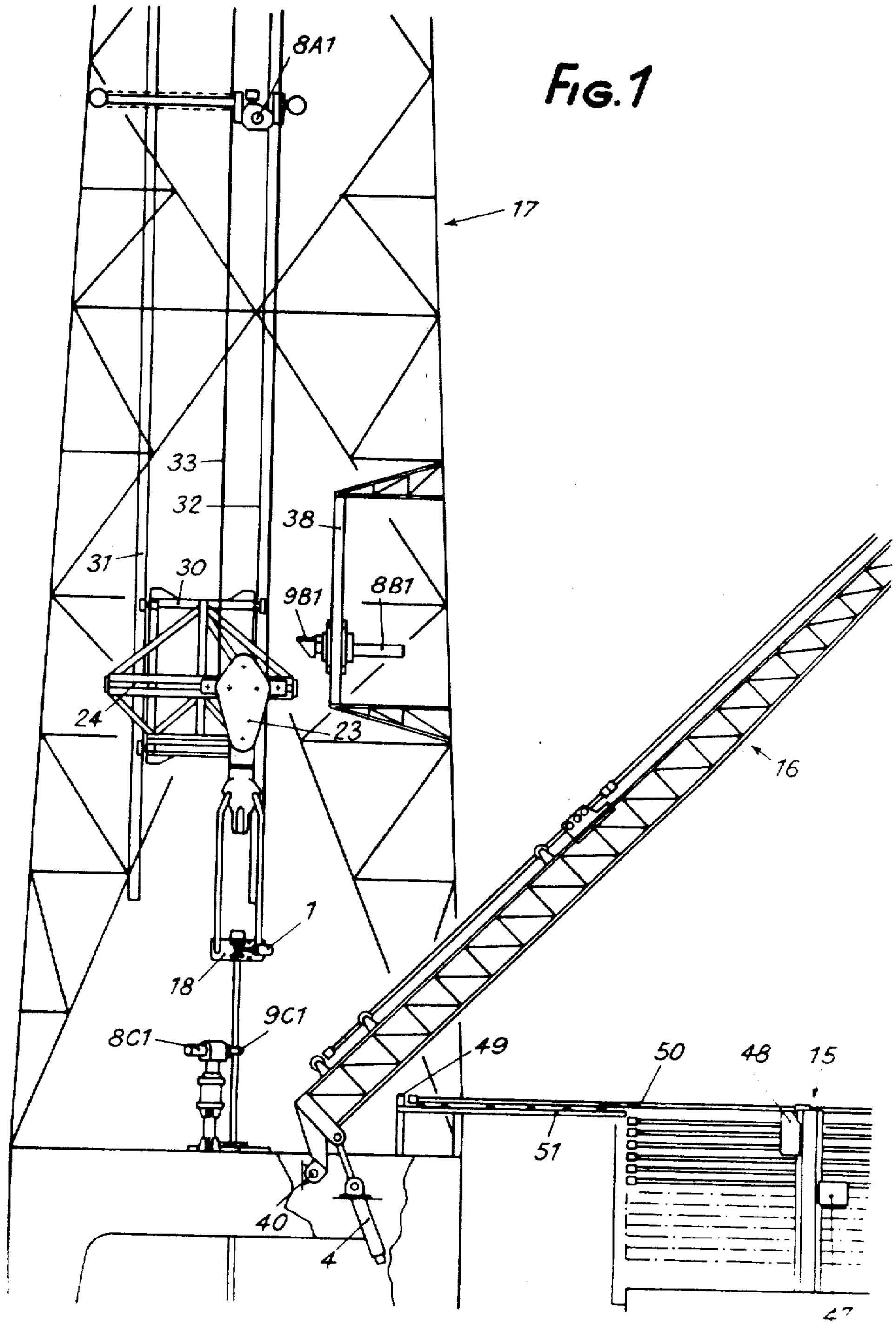

8A1
17
33
32
38
31
30
9B1
8B1
24
23
16
1
18
8C1
9C1
49
50
48
15
51
40
4
47

FIG. 1

FIG. 2

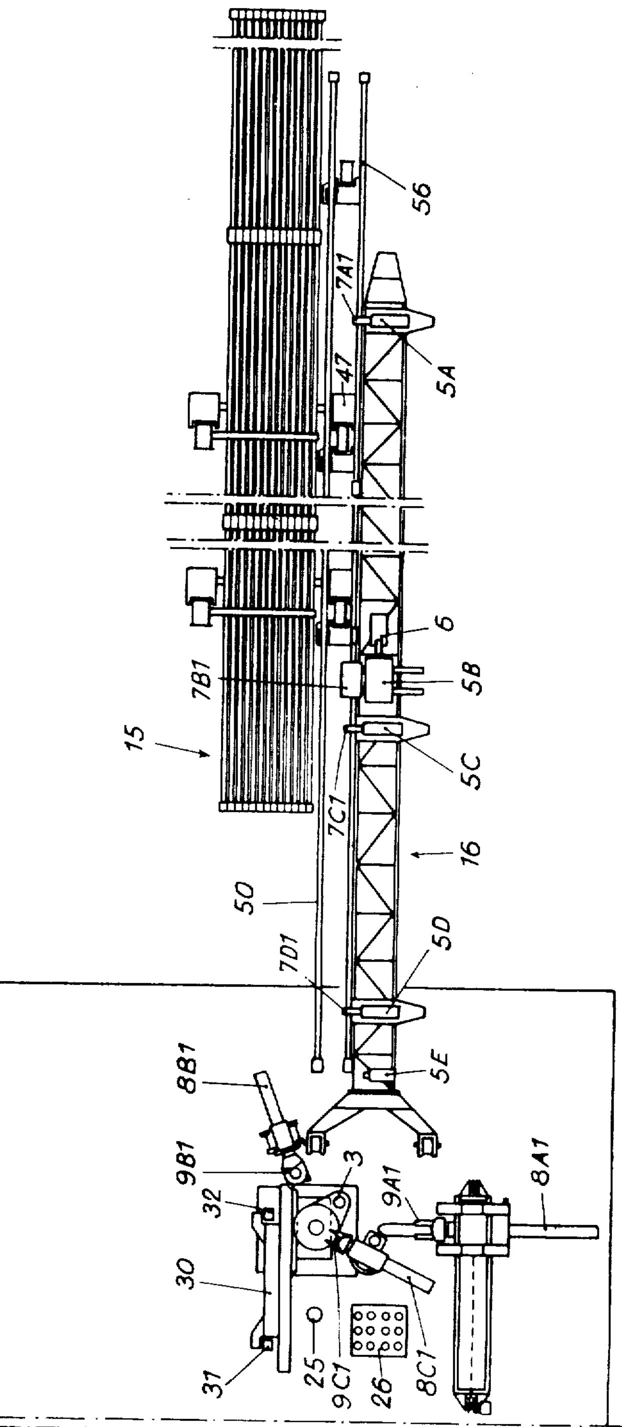

56
7A1
47
5A
6
7B1
5B
15
5C
7C1
16
50
7D1
5D
5E
8B1
9B1
3
32
9A1
8A1
30
25
9C1
26
8C1
31

FIG. 3

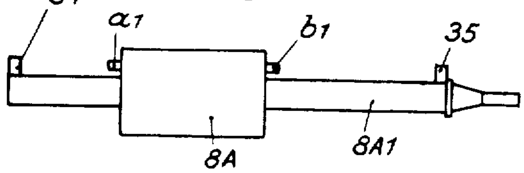


FIG. 4

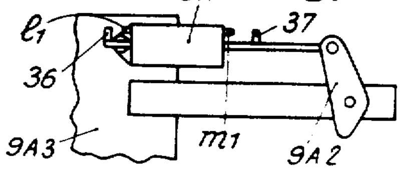


FIG. 5

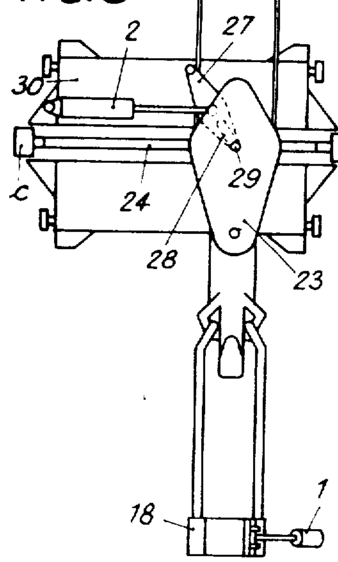


FIG. 7

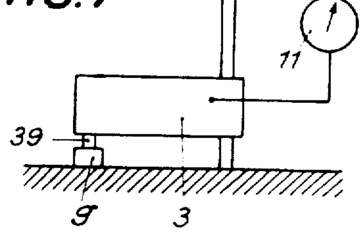


FIG. 8

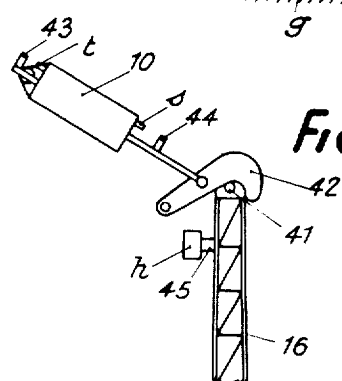


FIG. 6

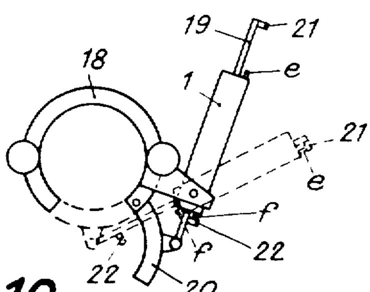


FIG. 9

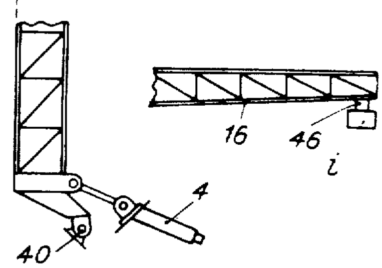


FIG. 10

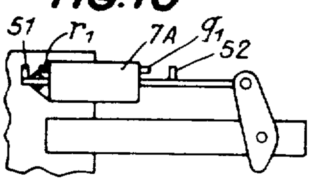
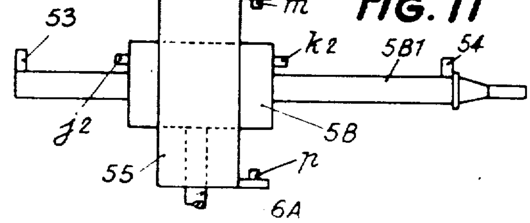


FIG. 11



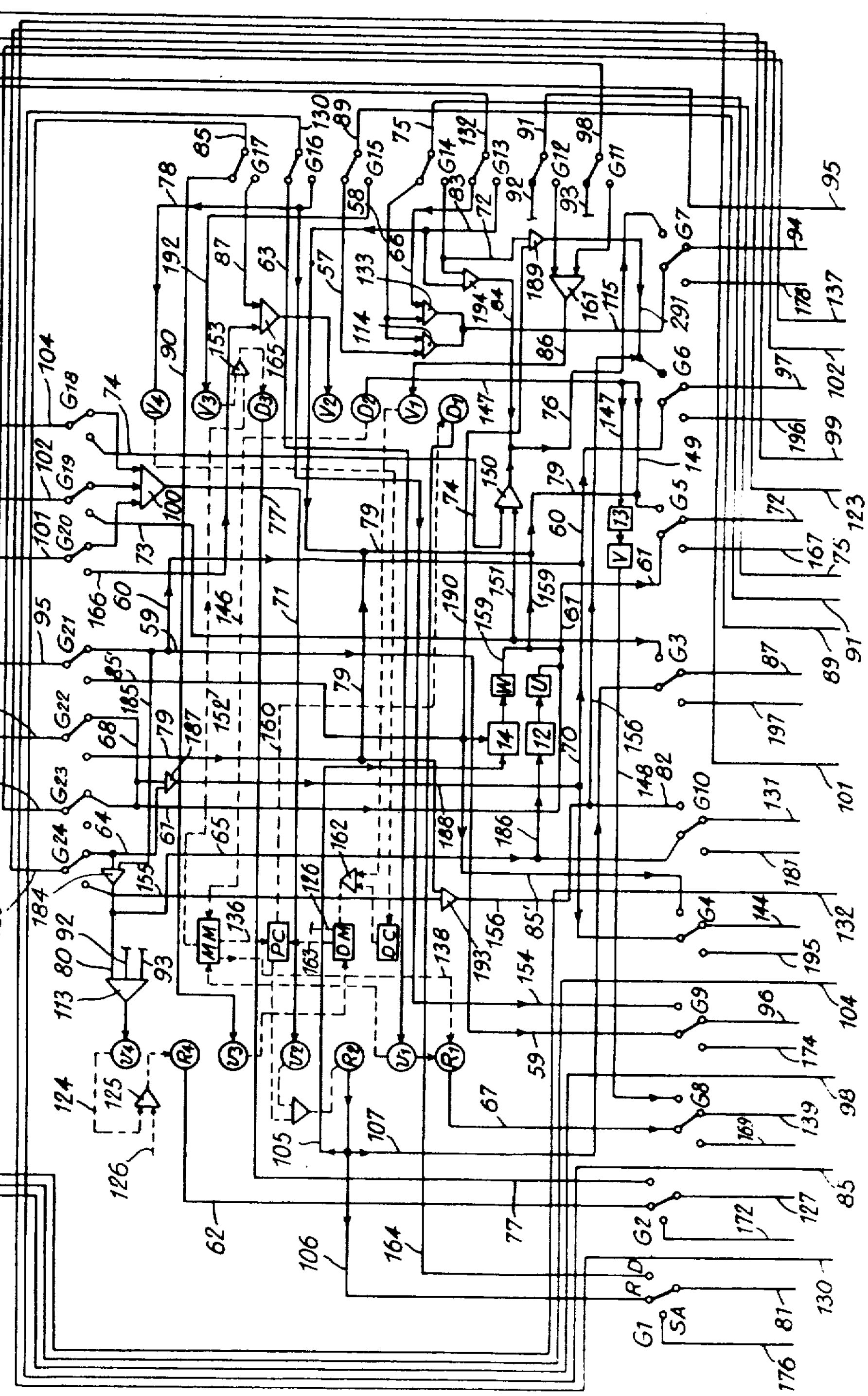


FIG. 12

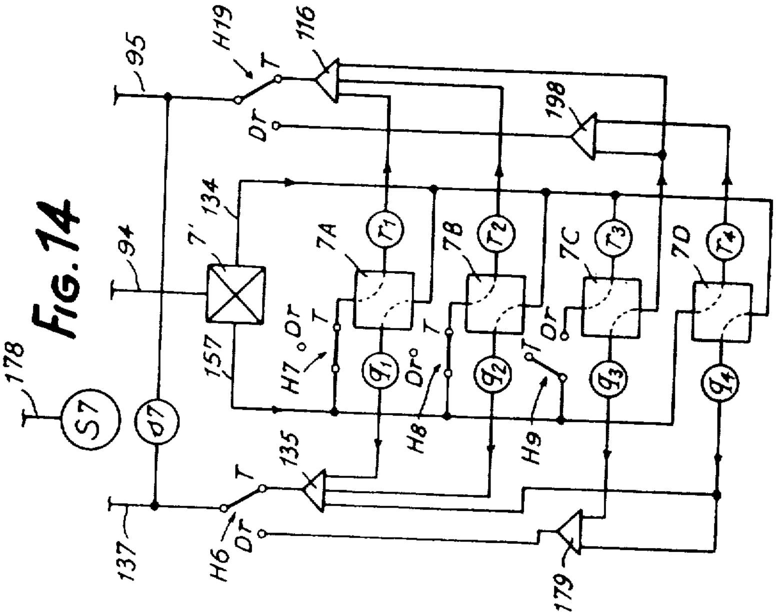

178
S7
d7
137
H6
DT
T
135
157
H7
H8
H9
q1
q2
q3
q4
7'
134
94
7A
7B
7C
7D
r1
r2
r3
r4
95
H19
116
198
179

FIG. 14

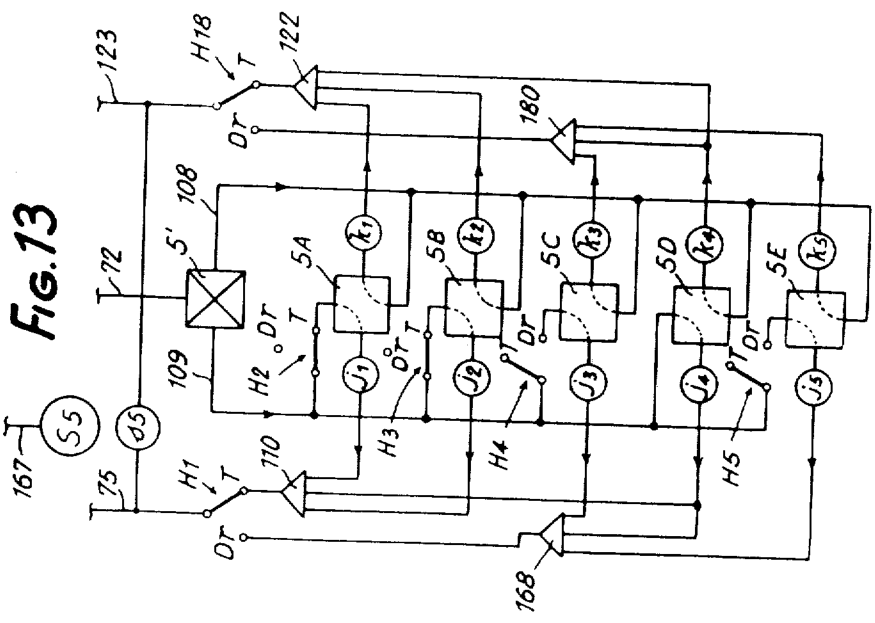

167
S5
d5
75
H1
110
168
109
H2
H3
H4
H5
j1
j2
j3
j4
j5
5'
108
72
5A
5B
5C
5D
5E
k1
k2
k3
k4
k5
123
H18
122
180

FIG. 13

Fig. 15

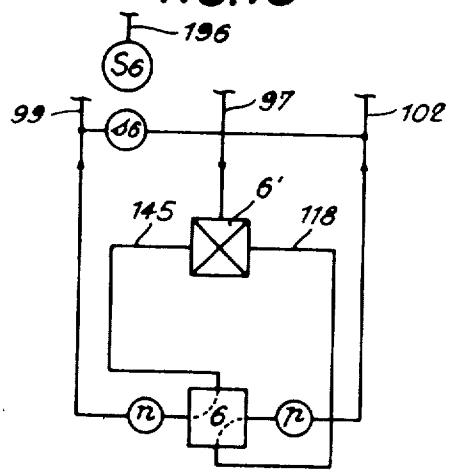

196
S6
99
s6
97
102
6'
145
118
n
6
p

Fig. 16

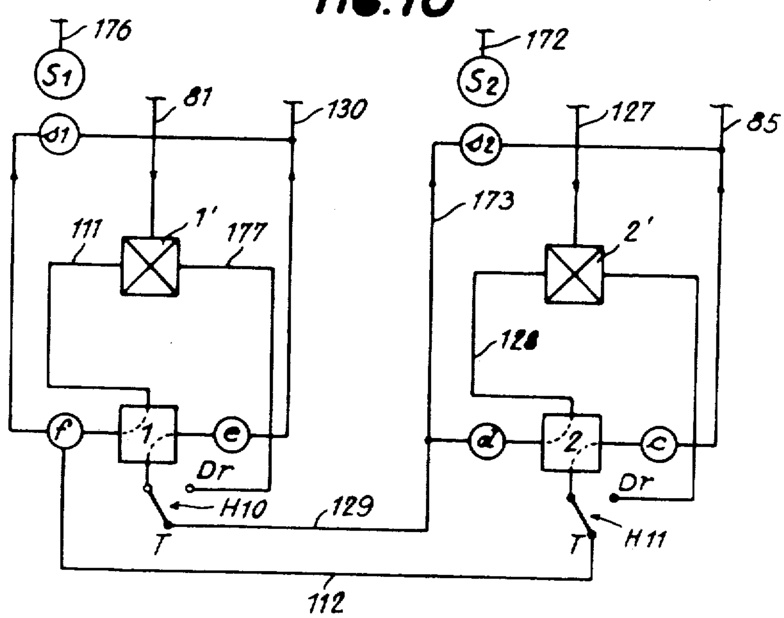

176
S1
81
130
s1
111
1'
177
f
1
e
Dr
H10
T
129
172
S2
127
85
s2
173
2'
128
d
2
c
Dr
T
H11
112

FIG. 19

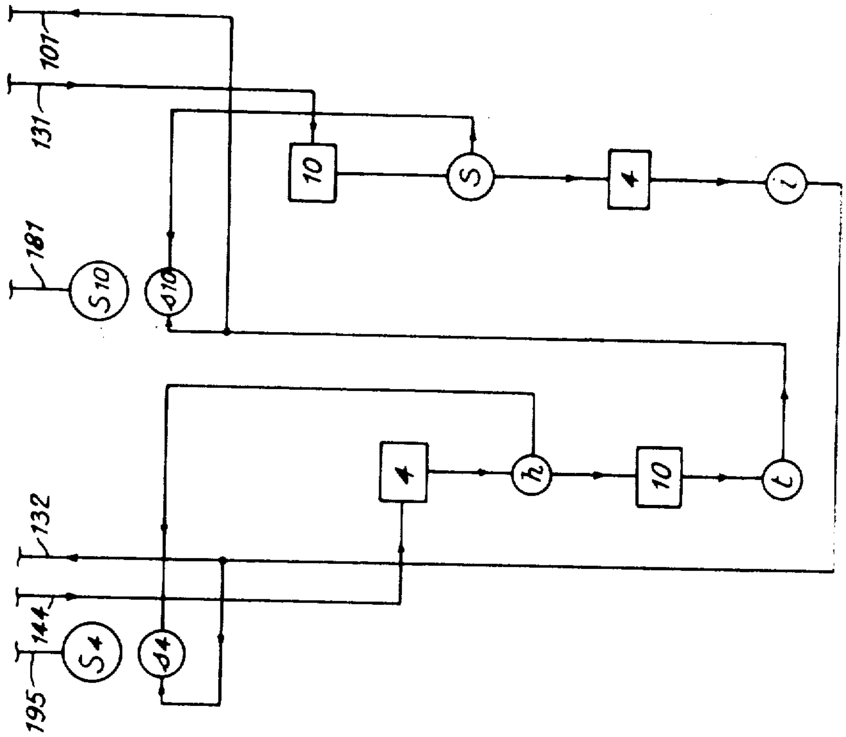
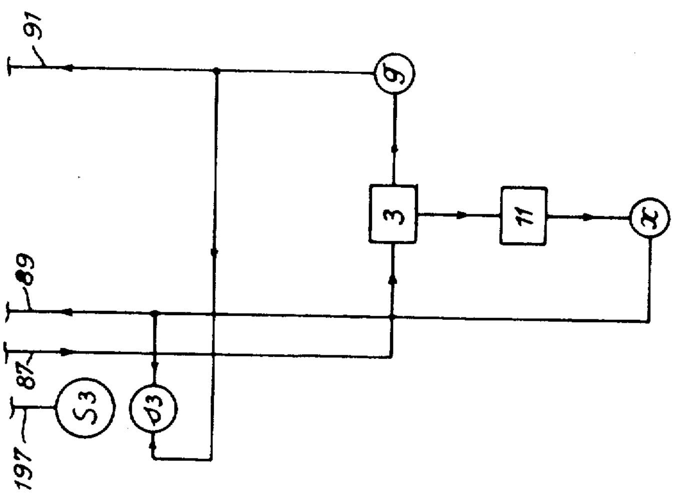

101
131
181
S10
s10
10
S
4
i
195
144
132
S4
s4
4
h
10
t

FIG. 17


91
89
87
197
S3
s3
g
3
11
x

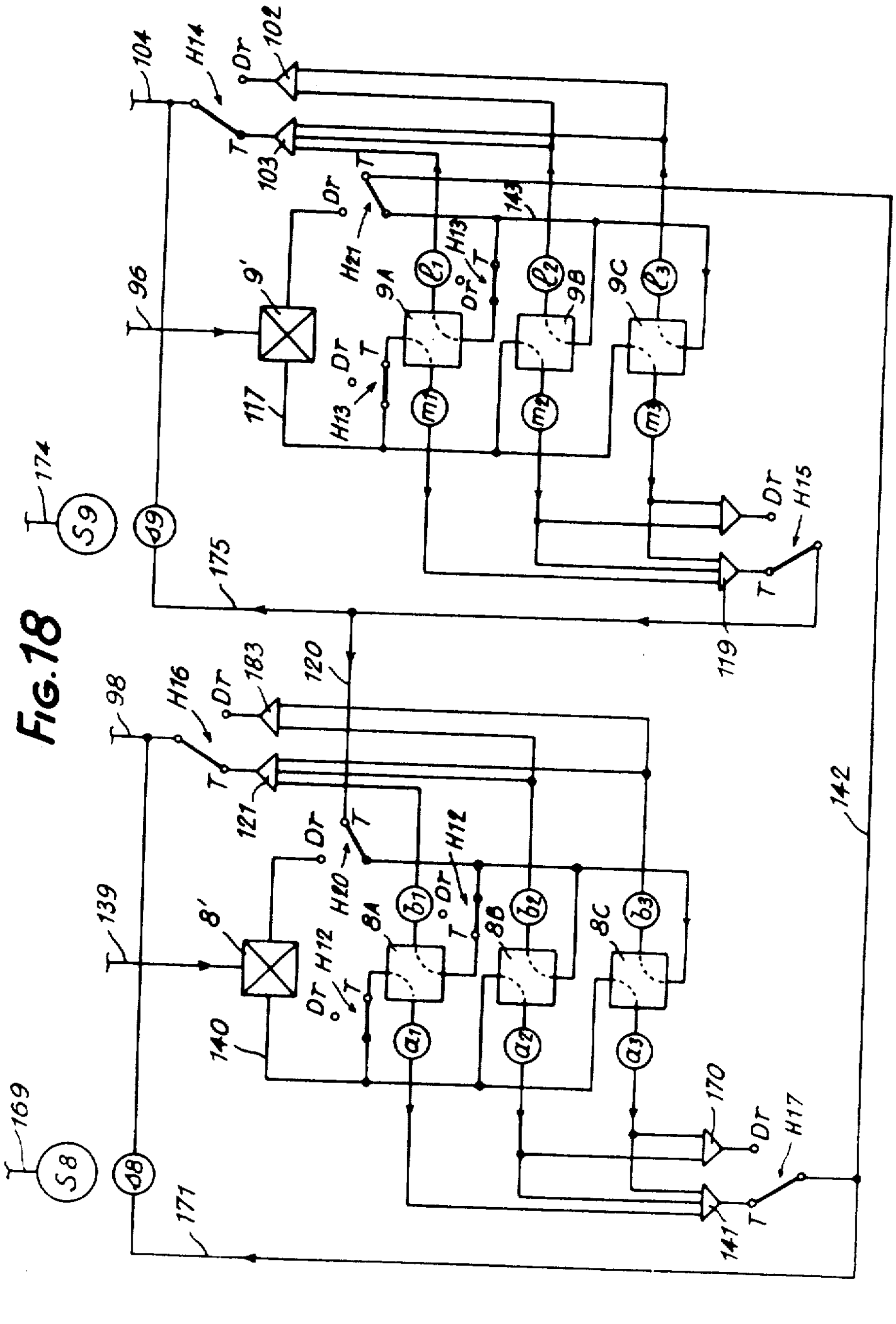
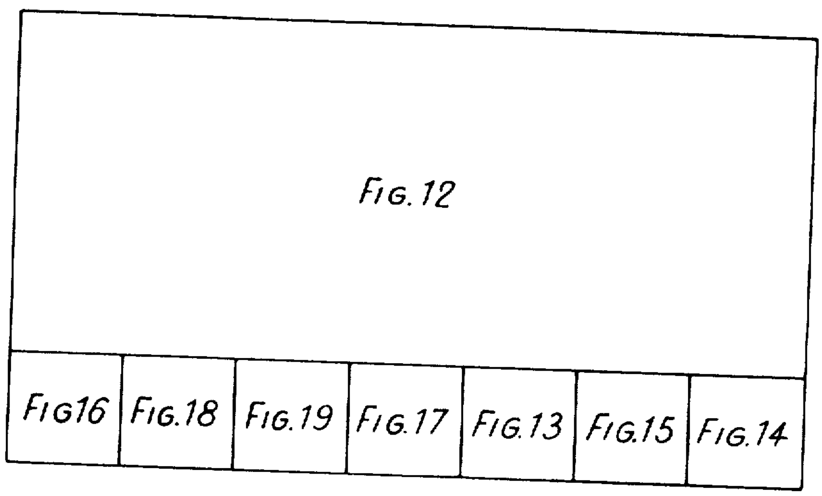


FIG. 18

FIG. 20



ROD STACKING AND HANDLING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to automatic rod stacking and handling apparatus, especially for drilling in the ocean, in which the rods are transferred to a derrick by means of a tipping girder, the entire assembly being designed to constitute a rapid and reliable automatic system.

2. Description of the Prior Art

There are already in existence stacking systems in which the rods are arranged in horizontal rows and are then put in the vertical drilling position in the derrick. These systems perform this transfer operation either with the help of a mobile arm, provided with a device for grasping the rod to be transferred, the two ends of the arm being guided in rails, or with the help of the pulley-block of the derrick which is connected to a tightening collar, placed at one end of the rod, the other end being borne by a cart. With the help of a tipping girder, such systems can move the rod directly into the axis of the rod train.

Although these systems make it possible or would make it possible, in the case of some of them, to hold 27-meter rods, none of these systems simultaneously meets the criteria of reliability, safety, speed, and economy required in a modern ocean drilling installation.

By way of example, the systems using a tipping girder for the transfer of rods from a horizontal position to a vertical position situated in the axis of the drill hole, require a radical change in conventional derricks so as to prevent the loss of time which would result from having to raise the conventionally designed handling pulley block prior to bringing up a new rod. In effect, if we want to increase the speed of the system, the rod must be centered automatically and must be raised or lowered automatically by means of a special lifting head, with an automatic key of a novel type assuring the maintenance of the train of rods during the screwing or unscrewing of the rod that is being held. This then leads to a rather cumbersome and awkward solution.

The system using the pulley block of the derrick to move the rod from a horizontal position into a vertical position is worthwhile in that none of the conventional members of the derrick is in any way affected, but it does entail the inconvenience of mobilizing the pulley block, which in turn leads to a major loss of time, particularly every time the drilling tool must be changed.

As to the utilization of a transfer girder guided with the help of rails at each of its ends, this solution entails the inconvenience of having to control the complex movement and supplying energy to the mechanical members carried on such a girder.

Furthermore, the systems for lining up the rods in a horizontal position are more or less adapted to the automatic pick up of rods with the help of a tipping girder and do not lend themselves to flexible, reliable, and rapid transfer automation.

Finally, we do not know of any system capable of manipulating the heavy elements, such as pipes and drill collars, without the risk of danger to personnel because of the always unforeseeable displacements in the case of marine drilling where such heavy elements can always be shifted freely within a certain area in the course of their manipulation.

SUMMARY OF THE INVENTION

The primary object of this invention consists of a rapid, economical, and highly reliable system, characterized by the fact that it involves, in combination: (a) a derrick including, in addition to the maneuvering arms, the pulley block, the elevator and its collar, a holding means, and a means for moving the pulley block outside the drilling axis, the pulley block being capable of shifting vertically in its new position; and (b) a girder tipping around the horizontal axis including retractable means for grasping a rod in order to move it from a horizontal position into a vertical position and vice versa, one of said grasping means involving a locking mechanism capable of grasping the rod in order to move it perpendicularly to the axis of the girder.

Another object of the invention is a stacking system for drilling of this type, involving furthermore a station for the horizontal line up of rods, including means for moving each rod over a precise distance from the axis of said girder, when the latter is in a horizontal position, as well as means for moving the end of each rod perpendicularly to a precise point on the axis of the girder, the rotation axis of the girder itself being situated on the derrick in such a position that the tipping of the girder, carrying a rod picked up by said grasping means in a retracted position, will move said rod outside the track of the pulley block into a nonstaggered position, said grasping means in the nonretracted position moving the rod into the axis of the drill hole.

Such a system offers many advantages. We might note that, contrary to certain automatic assemblies, it can be used with such component parts of the normal derrick as the winch, the pulley block, the automatic rod screwing and unscrewing device, constituting the train of drilling rods, while providing a reliable and rapid system.

In effect, a rod, which can be moved on the derrick into the vertical position outside the track of the pulley block when the grasping means of the grider are retracted, permits simultaneous operations. Furthermore, since the pulley block can be staggered outside the axis of drilling, it is possible, without waiting for the pulley block to come back up, to place a rod, grasped by the girder, in the axis of the drill hole by simply displacing said retractable grasping means. Thus, contrary to the earlier devices, where the transported rod had to be held up until the pulley block had come back up, and contrary to the special derricks requiring modifications in the pulley block and making it possible to hold only rods of small dimensions, e.g., about 9 meters, it is now possible, by virtue of the combination accomplished here, rapidly to move a large dimension rod, e.g., about 27 meters, into the axis of the drill hole, the pulley block being able to go back up during said operation.

Another object of the invention is a stacking system of the type indicated whose pulley block staggering device involves a slide bar along which the pulley block can move, with a cart supporting said slide bar and a jack, said cart being guided vertically by means of two rails and said jack displacing the pulley block from a first position, in which the axis of the pulley block coincides with the axis of the drill hole, to a second position situated in the vertical axis of the mouse hole.

The importance of such a device results not only from the possibility of rapidly moving the pulley block out of the way, but also from the fact that it permits the descent or rise of the pulley block during the performance of any other operation in the axis of the drill hole, such as the movement of a new rod, for example. Furthermore, the coincidence of the axis of the pulley block, in the offset or out of the way position, and the axis of the mouse hole makes it possible to add rods more simply and consequently faster than with the earlier systems since the screwing is performed in the vertical position, and no longer in an oblique position.

Another object of the invention is an automatic stacking system of the type indicated, in which said tipping girder furthermore involves a means for engaging or hooking onto its upper portion, cooperating with a locking device attached on the derrick, with a view to positioning the transported rods with precision, as well as a lower stop to support heavy elements, such as drill collars and pipes, the position of the stop on the girder being such that, when the girder is tipped into the vertical position, it is at a vertical distance from the joint having to receive the new rod or element and this distance is less than 30 cm.

This device not only facilitates the precise and reliable manipulation of rods but also that of heavy elements, such as pipes and drill collars, since these elements are transported by said tipping girder until they are in the vertical position above the axis of the drill hole and these elements are positively retained thereon. In this way we avoid the risks of danger produced by the fortuitous displacements of these elements in the course of their handling and especially the displacements caused by a swell, in the case of a maritime installation. This system furthermore offers the advantage of increasing the speed of the placement of the elements since the latter are moved to the proximity of the tightening device.

Another object of the invention is the system of the type indicated, each of whose displaced components, such as the pulley block moved beyond the axis of the drill hole, grasping means moved away from their initial grasping position, tightening mechanism, and girder tipped from a horizontal position to a vertical position, is associated with two members each of which transmits a control signal, one signal when the member is in its initial position and the other signal when said member has been displaced to a second position. Each of said signal transmission members is activated by the displaced member or by its moving mechanism arriving at the end of its travel, similar transmitter members being furthermore provided on the arms and the nippers of the derrick as well as on the collar of the elevator and the rod tightening mechanism, control connections, associated with triggering means operated by the operator, being provided between said control signal transmission members and said members serving for the displacement of the various above mentioned components, so that: (a) the triggering of similar member displacement means belonging to one and the same assembly; assembly of nippers of derrick, assembly of arms of derrick, assembly of thrust stop and of girder arms, and assembly of girder nippers, will bring about the simultaneous and synchronized displacement of the displacement members belonging to that same assembly; and (b) the displacements, within each assembly of similar members, will take place so as to accomplish the same function; either the retraction of the arms or the outward extension of the arms, or the closing of the nippers, or their opening.

In this way, we get an extremely flexible and reliable automation of the stacking system that is the object of this invention since it suffices to group the various automatic assemblies thus constituted in order to bring about the automatic performance of the operations of raising or lowering the train of rods. The automatic system may be either total or it may be limited, in which case the operator must, as in the past, control the winch of the derrick during the performance of a group of particular functions. The advantage of such a system is that it permits the automation of certain operations while still preserving the conventional components of the derrick.

Another object of the invention is a system of the preceding type, in which:

a. The control signal transmitting member, associated with the opening of the elevator, is connected to the means for controlling the offset movement of the pulley block outside of the axis of the drill holes;

b. The control signal transmission member, associated with the means for the control of the return of the pulley block into the axis of the drill hole is connected to the means for the control of the closing of the elevator;

c. The control signal transmission member, associated with the outward extension of the arms of the derrick is connected to the means for the control of the closing of the nippers of the arms of the derrick;

d. The control signal transmission member, associated with the opening of the nippers in the derrick, is connected to the means for the control of the retraction of the arms of the derrick;

e. A triggering member, handled by the operator, is provided for the individual control of the following components: the opening and closing of the collar of the elevator, the offsetting and return of the pulley block into the axis of the drill hole, the operation of the tightening key, the tipping and return of the girder into the initial position, the retraction and return of the girder arms, the raising and lowering of the intermediate arm of the girder, the opening and closing of the nippers of the girder, the extension and return of the arms of the derrick, the opening and closing of the nippers of the derrick and the locking-unlocking of the girder in the vertical position; and

f. A special switch enables the operator either to use said control means individually, when said switch is switched to a first control position, the so-called semi-automatic position, or to trigger the automatic performance of the operations of raising the train of rods when said switch is connected to a second position, or to trigger the automatic performance of the operations involving the lowering of the train of rods when said switch is switched to a third position, or to suppress the automatic and semi-automatic connections when the switch is switched to a fourth position.

Another object of the invention is a system of this type in which a portion of said grasping means, mounted on the girder, is utilized exclusively for holding the pipes and drill collars and another portion is utilized for holding the rods, a second switch member placing off-circuit the connections used exclusively for holding the rods when said second member is switched to a second position.

The system involved in this invention, therefore, enables us to easily proceed to automatic operations involving the raising and lowering of the rod train or of heavy elements such as pipes and collars by means of the successive activation of the means for the control of the displacement of the above mentioned components, since it suffices to manipulate, in addition to a simple switch mechanism for the purpose of switching from one automatic arrangement to another one, a second switch member for the purpose of changing from the holding of the rods to the holding of heavy elements.

Other objects and advantages of the invention will emerge from the following specifications given here with reference to the attached drawing which, by way of example, represents one way of implementing a stacking system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic elevational and partially cutaway view of the assembly of the mechanical parts of the system or apparatus of the present invention;

FIG. 2 is a schematic plan view of the system shown in FIG. 1, after the girder has been tipped into the horizontal position, with the metallic structure of the derrick being cut away and the components for holding the rods and the pulley block being shown;

FIG. 3 is a schematic elevational view of a device for the control of the displacement of one arm of the derrick;

FIG. 4 is a schematic elevational view of a device for the control of the mechanism used in closing and opening nippers of the derrick;

FIG. 5 is a schematic elevational view of the mechanism for the displacement of the pulley block on its support;

FIG. 6 is a schematic plan view of the collar of the elevator;

FIG. 7 is the schematic representation of the member of the key for tightening the rods on their joints;

FIG. 8 is a schematic elevational view of the girder in the vertical position with its locking device;

FIG. 9 is a schematic elevational view of the end of the girder tipped into the horizontal position;

FIG. 10 is a schematic elevational view of the device for controlling the opening and closing of one of the nippers of an arm of a girder;

FIG. 11 is a schematic elevational view of the mechanism for the displacement of an arm of the girder perpendicularly to the axis of the girder and of the mechanism for displacement parallel to the axis;

FIG. 12 shows the portion of the circuit diagram for the controls that start the automatic operation of the system;

FIG. 13 shows a portion of the circuit diagram shown in FIG. 12, relative to the control of the displacement of the arms of the girder perpendicularly to its axis;

FIG. 14 shows a portion of the circuit diagram shown in FIG. 12, relative to the control of the nippers of the arms of the girder;

FIG. 15 shows the portion of the circuit diagram of FIG. 12, relative to the control of one of the arms of the girder parallel to its axis;

FIG. 16 shows the portion of the circuit diagram of FIG. 12, relative to the control of the opening and closing of the elevator as well as to the control of the sideways staggering of the pulley block;

FIG. 17 shows the portion of the circuit diagram of FIG. 12, relative to the control of the tightening key;

FIG. 18 shows the portion of the circuit diagram of FIG. 12, relative to the control of the arms and the nippers of the derrick;

FIG. 19 shows the portion of the circuit diagram of FIG. 12, relative to the control of the tipping of the girder and to the control of its locking in the vertical position; and

FIG. 20 shows the diagram for the connection of FIGS. 13–19 to FIG. 12.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The automatic stacking system for drilling and especially for ocean drilling essentially involves a horizontal rod stacking device designated by reference 15, FIG. 1, the tipping girder 16 and a derrick 17. We will not describe each of these components of the system in detail since the horizontal stacking device has already been described in French Pat. application No. 6,938,751, filed by applicant on Nov. 12, 1969, under the title: "System for Lining Up and Withdrawing Rods in the Horizontal Position," the tipping girder 16 having been described in French Pat. application No. 6,939,135, filed by applicant on Nov. 14, 1969 under the title: "Tipping Girder for a Transfer of Rods or Tubular Elements Especially for Drilling," and the derrick here differing from earlier derricks only by virtue of the arrangements and the new components which alone will be described here.

To facilitate the explanation, we will assume that the two members associated with any displacement of the movable members of the system which each transmit a control signal in accordance with the invention (one, when the movable member with which it is associated is in the initial position, the other one when the movable member is in the displaced position), are constituted, for example, by a valve that is open when it is in contact with the displaced member or the means serving to displace it, said valve closing automatically the moment the displaceable member has left it in order to stop any distribution of control fluid.

It is clear that numerous other equivalent devices could be used and that said valves could be replaced by simple electrical contacts establishing a circuit controlling an electric valve. However, to clarify the circuits to be discussed later on, we assume that any signal transmission member will, when it is activated by a mechanical component, open a hydraulic control circuit. Such members are well known and are shown only schematically in FIGS. 3–11 by means of rectangles bearing references such as *a* to *t*.

For greater clarity and in order to facilitate the reading of the circuits, we have assumed that the signals transmitted by members, such as *u*, *w*, *n*, have a limited duration, so that the circuits controlling one and the same member act upon said member only for a limited duration of the automatic rod train rise or descent cycle.

Thus, collar 18 of the elevator, FIGS. 1, 5, and 6, supports a control member in the form of a jack 1 whose rod 19, attached by one of its ends to the pivoting portion 20 of the collar, involves two stops 21 and 22, cooperating respectively with the two control members or valves *e* and *f*, carried by jack 1. When the collar is in the open position, the valve *f*, activated by stop 22, allows the passage of control fluid, whereas in the closed position, shown in broken line 5, valve *f* is closed and valve e is opened to allow the passage of control fluid.

In a similar manner, pulley block 23, FIGS. 1 and 5, controls one or the other of the two control members or valves *c* and *d*, depending upon the position which it occupies on slide bar 24. According to the invention, the pulley block 23 may in effect be displaced with the help of jack 2 so as to occupy a first position in the axis of the drill hole, as shown in FIG. 1, and in this case, 23 is in contact with member *d*, or a second position, where it is in contact with member *c*. In this latter position, the axis of the pulley block coincides with the axis of the mouse hole 25, FIG. 2. Contrary to the floor of earlier derricks, the axis of the mouse hole is vertical and not obliquie, thus greatly facilitating the operations of adding the rods stored at 26. The transition of the pulley block 23 from one position to the other is accomplished by simply activating jack 2 whose rod end is pivoted on lever 27 having a groove 28 in which a shaft 29 of pulley block 23 is engaged. The slide bar 24 is mounted on a support cart 30 of the pulley block, said cart moving on the vertical guide rails 31 and 32, and cable 33 moving the pulley block vertically.

Each of the derrick holding arms 8A1, 8B1, and 8C1, FIGS. 1 and 2, has nippers 9A1, 9B1, or 9C1, and is controlled by mechanisms similar to those shown in FIGS. 3 and 4 so as to move toward the axis of drilling and so as to grasp the rods that are positioned there. In FIG. 3, the arm 8A1 is controlled by any mechanism, e.g., a chain controlled by a motor, and this mechanism involving the control members a1 and b1 activated respectively by stops 34 and 35, depending upon whether arm 8A1 is extended outwardly or is in the retracted position. For greater clarity, the mechanism for the opening and closing of nippers 9A1 is shown schematically at 9A, FIG. 4, this mechanism being mounted on support 9A3 of the nippers, the rod bearing the two stops 36 and 37 activating the closing lever 9A2 of the nippers. When the nippers are in the closed position, stop 36 activates the control member *l* 1, and when the nippers are in the open position, stop 37 activates member m1.

Similar mechanisms control the arms 8B1 and 8C1 as well as their nippers 9B1 and 9C1.

In addition to the radial or longitudinal movements of these arms, the upper arm 8A1 can be moved in a horizontal plane along two perpendicular directions, arm 8B1 can be moved also vertically along post 38, and arm 8C1 can pivot around the vertical axis of its support.

Tightening key 3 is of any known type and is shown schematically in FIG. 2 and FIG. 7. This device is associated with two control members shown symbolically by rectangles *g* and *x*. The first member *g* is activated every time the pushbutton 39 of member *g* is depressed by the descent of key 3, which occurs whenever the key 3, having been set in rotary motion and raised to tighten or loosen a rod on its joint, returns to its initial position. When the torque indicator *l* 1 indicates a predetermined value, member *x* is activated.

Girder 16, FIGS. 1, 8, and 9, pivots around the axis 40 of the derrick. It is set in motion by jack 4 and has in its upper portion a locking piece 41, on which is hooked the lock 42, controlled by the rod of jack 10. This lock has two control members *t* and *s* activated by stops 43 and 44 on the rod of the jack. When the girder 16 arrives in the vertical position, as shown in FIG. 8, it activates the member *h* by stop 45. When the girder is returned to the horizontal position by jack 4, another stop 46 triggers the control member *i*.

The device for moving rods 15 includes horizontal screw conveyors 47 which accomplish the perfectly parallel translation of the rods, which are then displaced vertically by vertical conveyors 48, after which they are advanced longitudinally to a stop 49 to assume the position of the rod 50 shown in FIGS. 1 and 2. The support level 51 of the rod 50 is such that, when the girder is in the horizontal position, its grasping arms are at the same level as the position of the rod 50 in the waiting position.

In the embodiment of the girder 16 shown in FIG. 2, only the nippers 7B1, function to engage 27 meter rods, such as 50, and support them. The other nippers 7A1, 7C1, and 7D1 serve as guides. The jacks 5A, 5B, 5C, and 5D control the displacement of the nippers perpendicularly to the axis of the girder, with jack 6 controlling the longitudinal displacement of nippers 7B1, and jack 5E controlling the displacement of a stop serving to support heavy elements such as pipes and drill collars.

By way of example, we have illustrated schematically in FIG. 10, at 7A, the jack for the control of the opening and closing of nippers 7A1. As in the case of the derrick nipper mechanisms, the jack rod has two stops 51 and 52, activating the control members r1 and q1, r1 being activated when the nippers are closed.

In FIG. 11, we have shown the control mechanism for the girder nippers 7B1 capable of being displaced longitudinally. Jack 5B, which controls the displacement perpendicularly to the girder, has two control members j2 and k2, activated by stops 53 and 54. Rod 6A of jack 6 displaces the jack assembly 5B toward the interior of the support 55, rigidly attached to girder 16. When jack 5B is moved toward the top of the girder by rod 6A of jack 6, it activates control member *m*. Inversely, when jack 5B is moved toward the bottom of the girder by rod 6A, it activates the control member *n*.

We note furthermore that, when the girder 16 tips or pivots into the vertical position, a rod 56 mounted thereon is removed from the axis of the drill hole. In order to move the rod 56 into the drill hole axis, the nippers 7A1–7D1 are moved transversely outwardly from the girder and then nippers 7B1 are longitudinally displaced by the jack 6 so as to move the rod into a position suitable for being screwed, for example, to the train of rods. The lower stop of the girder 16 is at a short distance from the tightening key 3, which enables us to increase the speed of handling. This is particularly important when the element transported is a heavy element, such as a pipe, which only has to be displaced over a short vertical distance in order to put it in tightening position on its joint.

The possibilities offered by this invention will be further discussed in the course of the detailed description of the circuits connecting the various control members or valves shown in FIGS. 3–11.

In FIG. 12, the elements G1 to G24 represent, in a symbolic manner, switches which can be moved to connect a circuit with one or another of four lines, one being destined for automatic rod train lifting operations; another one for automatic rod train lowering operations; the third for the semi-automatic operations of the members of the system with a view to accomplishing special holding operations relative to the placement of tubing, for example; and the fourth being used for manual operations. It is clear that the positions of members G1 through G24 can be changed by the use of a single general switch.

For greater clarity, we have shown three lines for the switches G1 to G10 and two lines for the switches G11 to G24, all of them being switched onto the automatic control line for raising the rod train.

The connection of the circuits shown in FIGS. 12–19 is accomplished in accordance with the scheme in FIG. 20. The representation of the connection circuits between the various members described earlier has been designed to facilitate the explanation here but it goes without saying that the hydraulic circuits represented here involve valves permitting the circulation of control fluid exclusively in the direction indicated by the arrows and that, in fact, the diagram could be modified depending upon the technique adopted, particularly if all or a portion of the control members are replaced by electric valves.

We will first of all concentrate on the case where the rod train must be raised. For this purpose, the operator turns the general switch to the R position and the switch H, controlling the communication of switches R1 to R21, to the position D, so as to eliminate the connection circuits relative to the members that are exclusively used for pipe handling.

We will assume first of all that the operator has checked to make sure that the girder **16** is locked in the vertical position, that the intermediate nippers 7B1 of the girder are in the low position, and that the arms 8A1–8C1 of the derrick are retracted, with their nippers being closed. If these conditions have been met, the light v2, FIG. 12 is turned on by circuit 71, connected to the output of circuit ET100, which is activated by the simultaneous presence:

a. of the signal transmitted by the control member *t*, FIG. 19, signaling the locking of the girder in the top position, the member *t* being activated by the exit of jack rod **10** and *t* being connected to **100** by line **101**, FIGS. 12 and 19;

b. of the signal transmitted by member *p*, FIG. 15, indicating the placement, in the low position, of the jack 5B of the girder, member *p* being connected to **100** by line 102, FIGS. 12 and 15; and

c. of the signal coming from the simultaneous control of the member *l*1, *l*2, and *l*3, FIG. 18, indicating the closing of the three nippers of arms 9A, 9B, and 9C of the derrick, this signal being transmitted by the output of circuit ET **103** connected to terminal T of H14 whose common terminal is connected to wire **104**, FIGS. 18 and 12.

When light v2 is on, the operator pushes pushbutton R2, FIG. 12, which simultaneously triggers three members: the jacks of the girder, the collar **18** of the elevator, and the tightening key **3**, these members being activated by connections **105**, **106**, and **107**. The connection **105** activates the jacks 5A, 5B, and 5D of the girder, FIG. 13, i.e., the upper, middle and lower nippers carrier arms. For this purpose, **105**, FIG. 12, activates a delay timer **14** which in turn activates control member *w* and by **61**, G5, and **72**, FIG. 13, the activation of member 5' which activates the double action jacks 5A to 5E, bringing about the exit or reentry of the girder arms, the control being performed by line **108** if the arms are out and by **109** if they are back in. When the jacks are in the withdrawn position, the control is then performed by **109** bringing about the activation of jack 5A by H2, of jack 5B by H3, and of jack 5C, the switches H having been switched to T.

The three jacks are then extended when the corresponding control members j1, j2, and j4 have been activated, each bringing about the transmission of a signal to the device ET **110** whose output is transmitted by H1 and 75.

The connection **106**, FIG. 12, activates the opening of the collar of the elevator controlled by jack **1**. For this purpose, connection **106** leads through G1 to the connection **81** triggering by means of 1', FIG. 16 (whose role is similar to 5' as indicated in the symbolic representation adopted for FIGS. 16 and 13), the control of the re-entry of the rod of jack 1 by line **111**. At the end of the run, the rod activates the member *f* which, through **112** and H11, controls the withdrawal of the pulley block **23** through the activation of jack **2**. At the end of the return run of jack rod **2**, the control member *c* transmits a signal through connection **85** to light v3.

The connection **107** controls the automatic tightening key **3** by means of G3 and connection **87**, FIG. 17. When the torque exerted by key **3** reaches a certain predetermined value, shown by indicator **11**, the latter activates member *x*. This member lights up the lamp s3, and through **89** and a connection to be described later on, prepares for the activation of the nippers of the girder.

We note that we have allocated to each assembly of control circuits a lamp s1 to s10 which enables the operator to follow the performance of the cycle at any instant. These signals, which activate these lamps, also serve for the control of the members placed in action here so as to accomplish the automatic rod train raising or lowering operations and for this purpose the connection between the lamps and said members are controlled by switching members G1 to G24, controlled by the general switch.

The sideways movement or offset of the pulley block, by means of member c, FIG. 16, produces a signal transmitted by **83**, G17, FIG. 12, and the connection **90** lights up lamp v3. In broken lines, we show a connection between v3 and the pulley block descent control member DM to indicate that the operator can directly control the winch which lowers the pulley block **23** or that an automatic circuit controls the member DM.

On the other hand, the return of the tightening key **3** into the rest position brings about the activation of contacts *g*, FIG. **17**, which transmit a signal via **91** and G12, FIG. **12**, to line **92** leading to device ET **113**.

Similarly, member *x*, FIG. **17**, placed in action by torque indicator **11**, transmits a signal via **89** and G15, FIG. **12**, leading via **57** to the device ET **114**, whereas the signal coming from device ET **110**, FIG. **13**, and indicating the end of the girder jack extension operation, is transmitted by **75** and G14, FIG. **12**, to the connection **58**, leading to the device ET **114**. The simultaneous presence of signals at **57** and **58** enables us to arrange, at **115**, an output signal transmitted by G7 and **94**, FIG. **14**, to the inverter **7'** and from there to the control jacks 7A, 7B, and 7D of the nippers of the girder which close tight on the rod. At the end of the run, the rods of these jacks activate members r1, r2, and r4, transmitting a signal to the device ET **116**, H19, the connection **95**, FIG. **12**, and G21 and from there toward lines **59** and **60**.

Through **59**, G9, and line **96**, FIG. **18**, the signal activates **9'** and, through **117**, the opening of the nippers 9A, 9B, and 9C of the derrick, whereas, through line **60**, G6, and **97**, FIG. **15**, the signal activates the rise of the the middle jack of the girder through the activation of the inverter **6'** and then of jack **6** via **118**.

At the end of the run of the mechanisms of 9A, 9B, and 9C, the members m1, m2, and m3, respectively, transmit a signal whose coincidence permits the passage of the signal to the output of device ET **119**, connected, by connections **120** and H20, to the control members of mechanisms 8A, 8B, and 8C, bringing about the return of the arms of the derrick. At the end of the run, these mechanisms activate, respectively, the control members b1, b2, and b3, transmitting a signal whose simultaneous presence permits the transmission of the signal to the output of device ET **121** and via H16, to the connection **98**, FIG. **12**, leading via G11 and **93** to the device ET **113**.

When jack rod **6** finishes its run, the middle jack of the girder is in the top position and activates the member *n* which transmits a signal via **99**, FIG. **12**, G23, **61**, G5, **72**, FIG. **13**, and activates the inverter **5'**, activating the retraction of the arms of the girder by the activation of jacks 5A to 5E via **108**. At the end of the retraction of the girder arms, k1, k2, and k4 transmit a signal whose simultaneousness permits the transmission of a signal to the output of a device ET **122** and via H18 and the connection **123**, FIG. **12** to G24, then via **64** to the device ET **184**. The signal available at G11, coming from the members r1, r2, r4, FIG. **14**, through wire **94**, is also transmitted to ET **184** via derivation connection **185**, so that a signal is available at **180** connected to the device ET **113**.

The simultaneous presence of a signal on line **80**, **92**, and **93** brings about the transmission of a signal to the output of ET **113** which lights up a lamp v4.

In a first variation, the operator directly activates the pushbutton R4 the moment lamp v4 goes on and the moment the pulley block **23** has completed its descent.

According to a second variation, a signal is transmitted by v4 and it is transmitted by **124** to circuit ET **125**, while a second signal, transmitted at the end of the run of the pulley block **23** and shown schematically by the junction of DM and of line **126**, is transmitted to the device ET **125**, controlling R4, in case of the simultaneous presence of signals on lines **126** and **124**.

The operation of button R4 brings about the activation of jack **2** by line **62**, G2, line **127**, FIG. **16**, **2'** and **128**. Jack **2** returns the pulley block **23** to its original central position with the pulley block then activating the member *d* at the end of the run. The signal transmitted by *d* is transmitted, via line **129** and via H10, to jack **1**, which, by closing the collar **18** of the elevator, activates at the end of the run of its rod, the member *e* which in turn transmits a signal. This signal is transmitted via **130**, FIG. **12**, G16 and **63** thus lighting up v1.

When light v1 goes on, this activates the rise of the pulley block **23** whose winch may be operated either manually or automatically as indicated by the dotted line connecting v1 to MM.

On the other hand, while the control member *k* transmitted a signal to connection **80**, a signal was also being transmitted to jack **10** for the unlocking of the girder by **65**, G10, and **131**, FIG. **19**, as well as to the delay timer **12** via lines **65** and **186**.

When the girder is unlocked, that is to say, at the end of the run, the rod of jack **10** activates member *s*, the latter activates the return of the rod of jack **4**, returning the girder to the horizontal position. In this position, control member *i* transmits a signal through line **132**, FIG. **12**, and G13.

On the other hand, the delay timer **12**, FIG. **12**, activates the control member *u*, which, through connection **61**, G5, **72**, FIG. **13**, the inverter **5'**, the line **109**, brings about the outward extension of the jacks 5A, 5B and 5D of the girder, activated in parallel as described earlier. As we saw before, the outward extension of the activated jacks produces, through j1, j2, and j4, a signal transmitted via **75**, FIG. **1**, and G14.

The simultaneous presence of a signal on lines 5B and **66**, connected respectively with G14 and G13, brings about the transmission of a signal to the output of **133** which is transmitted via **115**, G7, and **94**, FIG. **14**, to the inverter member **7'**. With the girder nippers closed, the member **7'** brings about the withdrawal of the rods of jacks 7A, 7B, and 7D via line **134**.

At the end of the run of rods of jacks 7A, 7B and 7D, the members q1, q2, and q4 transmit a signal which is transmitted to the device ET **135** and from there via H6 and **137**, FIG. **12**, G22, **68**, **61**, G5, **72**, FIG. **13**, to the inverter **5'**, with a view to the withdrawal of the girder jacks.

During the tipping of the girder **16**, the pulley block **23** continues to go up. At the end of the run, it is then possible to order the placement on wedges and to trigger the button R1, as indicated by dotted lines **136**, connecting MM and PC and **138** connecting MM to R1.

The triggering of R1 produces, via **67**, G8, and **139**, FIG. **18**, the activation of the inverter **8'** and, consequently, the outward extension of the arms of the derrick by mechanisms 8A, 8B, and 8C through **140**. At the end of the run, the rods of these jacks activate the control members a1, a2, and a3, transmitting a signal to the device ET **141** and from there, via H17, **142**, H21, **143**, to jacks 9A, 9B, 9C, bringing about the closing of the nippers of the arms of the derrick and, at the end of the closing, the activation of control members *l*1, *l*2, and *l*3. These members transmit a signal to the device ET **103**, controlling, via H14, **104**, FIG. **12**, and G18, a signal to ET 100.

During this period of time, the signal transmitted to the inverter **5'**, FIG. **13**, brings about, through **108**, the activation of jacks **5A**, **5B**, and **5D**. At the end of the run of the rods of these jacks k1, k2, and k4 transmit a signal which is transmitted, via ET **122**, **H18**, **123**, FIG. **12**, **G24** and **64**, to the device ET **187**, while the signal coming from members q1, q2, and q4, transmitted via **137**, **G22**, and **68**, is likewise transmitted to the same device ET **187**. The output of device **187** then transmits a signal which is directed, on **188**, on the one hand, toward G4 and **144**, FIG. **19**, to activate the jack **4** which returns the girder **16** to the vertical position, and on the other hand, via **70**, **60**, **G6**, **97**, FIG. **15**, inverter **6'**, connection **145** bringing about the descent of the middle jack of the girder.

When the girder arrives in the vertical position, the member *h*, FIG. **8**, triggers the locking jack **10** of the girder. The exit of the rod of this jack at the end of the run activates the member *t* which, through **101**, FIG. **12**, and **G20**, transmits a signal to the device ET **100**.

Likewise, when the rod of jack **6**, FIG. **15**, arrives at the end of the run, it activates member *p* which transmits a signal, via **102**, FIG. **1**, and **G19**, to the device ET **100**.

With a signal present at the three inputs of device ET **100** its output transmits a signal, via **71**, triggering the lighting of lamp v2, indicating that the cycle has just been completed. The operator can then start and identical cycle by once again operating button R2.

When we want to lower the rod train in automatic operation, it suffices to put the index of the general switch on stud D after making sure that the members are in a suitable position, that is to say, that the girder **16** is in the vertical position, that its arms are in the retracted position and hold a rod, that the pulley block **23** is moved sideways or offset, that the tightening key **3** is in the resting position, and that the arms of the derrick are in the retracted position.

The components set in motion during the automatic operation of lowering the rod train are the same as those volved in the rod raising operation and we will therefore indicate only the course of the successive operations.

Light **V2** is on and the operator activates the member MM for the raising of the pulley block **23** by depressing **D2**, if a direct connection, such as **146**, is provided, or he directly activates the corresponding winch in the absence of an automatic connection.

D2 controls the exit of the arms of the derrick through **147**, with the time delay member **13** activating *v*, the line **148** being linked to D by **G8**, the connection **139**, FIG. **18**, the inverter **8'**, **140**, and the mechanisms **8A**, **8B**, and **8C**.

D2 also activates the exit of the arms of the girder through **147**, **149**, connected to stud D of **G5**, **72**, FIG. **13**, **5'**, **109**, and the jacks **5A**, **5B**, and **5D**.

The members **a1**, **a2**, and **a3**, controlled by the exit of the arms of the derrick, FIG. **18**, through **H17** and **142**, control the mechanisms **9** for the closing of the nippers of the derrick arms.

Likewise, members **j1**, **j2**, and **j4**, FIG. **2**, controlled by the exit of the girder arms, transmit a signal via **110**, **75**, FIG. **12**, **G14** and **72**, to the device ET **189**. This same device also gets signal r1, r2, and r4, coming from **95**, FIG. **14**, since we supposed that the nippers of the girder were closed. Thus, the device **189** receives two input signals, one from the connection **72**, and the other one from the connections **95**, **G21**, **85**, and derivation **190**. From this there results an output signal **291**, **G6**, **97**, FIG. **15**, **6'**, **145**, with jack **6** bringing about the descent of the middle jack of the girder, thus assuring the engagement of the joint of the rod. At the end of the run of the middle jack, the member *p* is placed in action and, through **102**, FIGS. **15** and **12**, **G19** in the position D and connection **73**, transmits a signal to **b3**, which in turn is transmitted to the control **3**, FIG. **17**, of the tightening member of the joints via **87**. The signal coming from **73** is also transmitted to the device ET **150** via **151**, which when receiving a signal via **74**, coming from members *l*1, *l*2, and *l*3, FIG. **18**, via **104**, FIG. **12**, and **G18**, transmits a signal via **76**, **G7**, **94**, FIG. **14**, to **7'**, then via **134** to **7A**, **7B**, **7C**, and **7D** for the opening of the nippers of the girder **16**.

With the tightening key having been activated by means of **3**, FIG. **17**, the member *x* is activated the moment the tightening torque attains a predetermined value, lighting up the lamp V3 by means of **89**, FIG. **12**, **G15**, and **192**.

After the pulley block lifting member MM has been activated via D2, D3 can be depressed by the operator or it can be triggered automatically by the connection **152**. The device ET **153** receives two input signals and can in effect transmit an output signal at D3.

Its triggering brings about the activation of jack **2** through **77**, **127**, FIG. **16**, **2'**, and **128**, and, consequently, the centering of the pulley block **23** which brings about the closing of the elevator collar **18** through jack **1**, controlled by *d*, **129** and **H10**, FIG. **16**. At the end of the course of the rod of jack **1**, the member *e* emits a signal through **130**, FIG. **12**, **G16**, and **78**, thus lighting up lamp V4. Parallel to the illumination of V4, the connection **154**, connecting G16 to G9, transmits the signal, through **96**, FIG. **18**, to **9'** and from there, through **117**, to **9A**, **9B**, and **9C**, thus causing the opening of the derrick nippers.

During the screwing operation, the member **7**, controlling the opening of the nippers of the girder, brings about the activation of the members q1, q2, and q4, which, through **135** and **137**, FIG. **12**, **G22**, **79**, **G5**, **72**, FIG. **12**, **5'**, and **108**, bring about the command for the retraction of the arms **5A** **5B**, and **5D**. The corresponding members k1, k2, and k4 emit a signal, through **122**, **H18**, **123**, FIG. **12**, **G24**, and **155**, supplying the device ET **193** with power, while the connection **179**, connected to G22 and **137**, transmits, to the same device, the signal coming from q1, q2, and q4. From this results a signal at the output of ET **193** which is transmitted, via **156**, **G6**, **97**, FIG. **15**, **6'**, and **118**, to jack **6**, in order to raise the middle arm up to its initial position. The signal transmitted by the controls, of k1, k2, and k4, and q1, q2, and q4, is likewise transmitted, in parallel with **156**, to the connection **82**, and from there, via **G10** and **131**, FIG. **19**, to jack **10**, causing the unlocking of the girder and, consequently, the activation of control member *s*. The latter in turn activates jack **4**, moving the girder into the horizontal position.

At the end of the run of the girder, the member *i* transmits a signal, via **132**, FIG. **12**, G13, **83**, **79**, G5, **72**, FIG. **13**, **5'**, and **109**, to the jacks **5A**, **5B**, and **5D**, thus bringing about the exit of the corresponding arms of the girder. Through **110**, the members j1, j2, and j4 produce the transmission of a signal which is transmitted, via **75**, FIG. **12**, to the device ET **194**, while the signal i, coming from **132**, FIGS. **19** and **12**, reaches the same device. A signal is then transmitted through the output of ET **194**, **84**, **76**, G7, **94**, FIG. **14**, to the inverter 7' and from there, via **157**, to the jacks **7A**, **7B**, and **7D**, controlling the closing of the nippers of the corresponding arms and, hence, the members r1, r2, and r4. The latter transmit a signal via **116**, H19, **95**, FIG. **1**, G21, **85'** the delay timer **14**, with the member *w* activating 5' through **159**, **97**, G5, and **72**, FIG. **13**, and from there, via **108**, the jacks **5A**, **5B**, and **5d**.

The signal transmitted by **85'**, in parallel with the activation of delay timer **14**, brings about the activation of jack **4** through the connection: **85'**, G4, and **144**, FIG. **19**.

At the end of the opening of the derrick arm nippers, the members m1, m2, and m3, FIG. **18**, emit a signal, through **119**, **120**, H20, thus controlling the mechanisms **8A**, **8B**, and **8C**, bringing about the retraction of the derrick arms. At the end of the run, these mechanisms activate the members b1, b2, and b3, which transmit a signal, through **98**, FIG. **12**, and G11, to the device ET **161**. On the other hand, the tightening device **3** having been activated at the beginning of the cycle and having in turn activated *g* at the end of the work, a signal is then also applied to the device ET **161** through *g*, FIG. **17**, **91**, FIG. **1**, and G12. A signal is then transmitted through ET **161** and through **8b** up to lamp V1 which lights up.

The illumination of V1 and the unblocking of the wedges, activated during the illumination of V4, bring about the activation of the descent of the pulley block **23** by the member DM, as shown in device ET **162**. This operation is followed by a new placement on wedges, as indicated by connection **163**. When this has been completed, the operator can activate D1 as indicated by connection **160**.

The triggering of D1, through **164**, G1, **81**, FIG. **16**, **1'**, and **111**, brings about the activation of jack **1**, assuring the opening of the elevator collar. The member *f*, activated at the end of the run, in turn activates jack **2**, through **112**, and H11, thus bringing about the sideways staggering of the pulley block **23**. At the end of the run, the rod of jack **2** activates *c*, transmitting a signal, via **85**, FIG. **12**, G17, and **87**, to the device ET **165**.

Simultaneously, if the jack **4**, FIG. **19**, having been activated so as to return the girder into the vertical position, the member *h* activates the locking jack **10**, whose rod at the end of the run activates the member *t*. The latter transmits a signal through **101**, FIG. **12**, G20, and **166**, through the device ET **165**. The presence of a signal at the two inputs of the device then, through its output line, causes V2 to light up.

Since jacks **5A**, **5B**, and **5D** have been activated at the same time as the member *t*, the members k1, k2, and k4, indicating the return of the girder arms, return the corresponding circuits into the same initial state as at the beginning of the cycle, so that, when V2 lights up, the operator can start a new cycle.

The action of the control means for the various components is so designed as to permit the maneuvering of the tubing and the drill collars by simple switching so as to isolate, in the automatic control circuits which we have just described, the connections which normally bring about the transition from one operation to the next with a view to the automatic lifting or lowering of the rods. We thus limit the automatic portion to independent unique operations or to a limited sequence of operations involving non-independent members. Likewise, by switching we eliminate the connections that activate the members used exclusively for holding the rods. Thus, heavy elements are maneuvered under the control of an operator by means of a succession of simple operations offering the advantage of making automatic the performance of each operation or sequences of dependent operations, thus increasing the speed of maneuvering and the reliability of the entire assembly while retaining the simplicity of the maneuvers, in spite of the length intervals of the elements handled by the same members under automatic control.

It is thus possible very simply to switch from the operations of lowering and raising the trains of rods assembled in 27-meter elements to the manipulations of 9-meter drill collars or 9/14-meter tubing, for example.

For this purpose, the index of the general switch G is moved from R (or D) to SA, activating the connections corresponding to semi-automatic operations, and the index of switch H is moved from T to Dr. This switching enables us to select the members of the derrick and of the girder involved in the particular operations.

In order to facilitate the description, we will assume that we want to move a heavy tubing element or a drill collar and that, in the beginning, the girder is in the vertical position on the derrick, the heavy element being supported by stop **5E** and the jacks **5D** and **5C** being in retracted position, while the pulley block **23** has just been offset sideways.

Under these conditions, when the operator pushes the pushbutton **85**, FIG. **13**, he orders the extension of arms **5C**, **5D**, and **5E** of the girder through circuit **167**, FIG. **12**, G5, whose stub S.A. is then switched with **72**, FIG. **13**, 5', **109**, and in parallel, H4, H5, and the direct line connected to **5D**. At the end of the operation, the members j3, j4, and j5 are activated by the rods of the jacks and transmit a signal to the device ET **168** whose output is connected via **75** to s5 by means of H1 which is switched to Dr. The light s5 then goes on, warning the operator that the operation has been completed; he can then go on to the next operation, that is to say, the triggering of the outward extension of the arms of the derrick.

For this purpose, the operator simultaneously pushes pushbuttons S8, FIG. **18**, and S2, FIG. **16**, pushbutton S8 through **169**, FIG. **12**, G8, **139**, FIG. **18**, **8'**, and **140**, controls the mechanisms **8B** and **8C**, since **8A** has not been activated because of the opening of H12. The members a1 and a3 have been placed in action by the mechanisms reaching the end of the run; they transmit a signal to the device ET **170**, connected via H17 and **171** to s8. The light s8 goes on, warning the operator as to the exit of the middle arm **8B** and the lower arm **8C** of the derrick.

At the same time, **82** having been activated, jack **2** is activated by **172**, FIG. **12**, G2, **127**, FIG. **16**, 2', and **128**, so as to return the pulley block **23** to the axis of the derrick. At the end of the run, the member *d* transmits a signal via **173** to s2 which goes on.

After the exit of the derrick arms, that is to say, when **s8** is lit up, the operator activates S9, bringing about the closing of the nippers **9** via **174**, FIG. **12**, **96**, FIG. **18**, **9'**, **117**. The members m2 and m3 then bring about the emission of a signal which lights up the lamp s9 via **175**.

The operator can then activate S1, thus operating, by means of **176**, FIG. **12**, G1, **81**, FIG. **16**, **1'**, **177** and H10, the jack **1**, which closes the collar of the elevator. At the end of the operation, the member *e* transmits a signal which is transmitted via **130**, to the lamp s1 which goes on.

By activating S7, FIG. **14**, the operator opens the nippers of the arms of the girder by means of circuit **178**, FIG. **12**, G7, **94** FIG. **14**, **7'**, **134**, and in parallel 7C and 7D. At the end of the run of the rods of these jacks, q3 and q4 transmit a signal via ET **179** and **137** to s7 which goes on.

In order to pick up the weight of the pipe, the operator causes the pulley block **23** to rise and he activates S5 in order to withdraw the arms of the girder. The jacks 5C, 5D, and 5E are controlled through **167**, FIGS. **13** and **12**, **72**, FIG, **13**. **5'**, and **180**. At the end of the operation, s5 is lit up due to the activation of the signal emitted by k3, k4, and k5, **180**, H18, and **123**.

The operator then turns on the pulley block **23** in order to engage the joint of the tubing and simultaneously activates S10 in order to unlock and return the girder to the horizontal position. S10, by means of **181**, FIG. **1**, **131**, FIG. **8**, controls the jack **10**. At the end of the unlocking operation, the member *s* illuminates s10 and activates the jack **4** for the tipping of the girder.

The joint having been engaged and the screwing having been accomplished by conventional means, the operator then activates S9, FIG. **18**, which, through **174**, FIG. **1**, G9, **96**, and H21, causes the retraction of the rods of jacks 9B and 9C. The members **12** and **13** then, through **182** and **104**, cause s9 to light up.

The operator can then activate S8 for the retraction of the arms of the derrick which is accomplished by circuit **169**, FIG. **12**, **139**, FIG. **18**,**8'**, H20, and jacks 8B and 8C. The members b2 and b3 at the end of the operation cause s8 to be lit up by **183** and H16.

Once the girder has reached the horizontal position, the member *i*, FIG. **19**, transmits a signal which, through **132**, causes s4 to light up. The operator can then pick up a new element and for this purpose he successively activates s5, for the exit of the arms of the girder, S7 for closing of the nippers of the girder whose control is accomplished, FIG. **14**, by **94** and **157**, r3 and r4 emitting a signal at **198**, S4 for the raising of the girder whose control is performed by **195**, G4, and **144**, FIG. **19**, the jack **4** returning to the loaded girder into the vertical position and the member *h* causing it to be locked. The moment S4 triggers the lifting of the girder, the operator activates S5 in order to withdraw the arms of the girder.

During the performance of these latter operations, the first element has been screwed and the operator disengages the corners with the help of the pulley block **23** and then he sees to the lowering of the pulley block under load in order finally to put the pipes on the wedges.

The operator then activates S1, controlling the opening of the elevator, then S2, the moment s1 has lit up, so as to stagger the pulley blocks sideways. We are thus back at the initial conditions, so that it suffices for the operator to resume the succession of commands described previously.

It is clear that, since the middle jack of girder 5B has not been used, the operator did not have to manipulate button S6 which serves to raise or lower the middle jack arm as desired. For this purpose, S6, FIG. **15**, is connected by **196** to G6, FIG. **12**, and from there to **97**, connected to the previously described control for jack **6**, FIG. **15**. Likewise, the maneuvering of the tightening key **3** can be controlled as desired through S3, FIG. **17**, connected via **197**, FIG. **12**, to G3 and from there via **87** to the control of the mechanism **3**, FIG. **17**.

The action of the hydraulic circuits, which have just been described, by way of example in the form of a scheme, may take on many other forms especially when the members that transmit the control signals, such as *x*, *r*, *u*, etc., are electrical contacts. The conditions bringing about the activation of well determined members in the course of an automatic cycle can be replaced by combinations of equivalent conditions. By way of example, the condition where we have a signal *k* and a signal *r*, in the course of the automatic lifting of the rods for the control of jack **10**, could be replaced by the condition where we have signals *j* and *m*.

As to the arms equipped with stops or nippers, it is quite obvious that their number may vary and that any particular mechanism may be activated individually; these individual activation controls are known in themselves and can be of any suitable type.

What is claimed is:

1. Stacking and handling apparatus for drilling rods or tubular elements, comprising:

a. a derrick including movable rod holding arms, rigid vertically extending guide means, a rigid support vertically movable on said guide means, a pulley block slidably mounted on said support for lateral movement, an elevator secured to said pulley block and having a collar, means for laterally moving said pulley block to an offset position outside of the drilling axis, and means for moving said support and said pulley block vertically when said pulley block is in said offset position; and

b. a girder pivotable about a horizontal axis between vertical and horizontal positions and including retractable means for supporting a rod so as to take it from a horizontal position to a vertical position and vice versa, said supporting means having means for grasping the rod and moving it from a retracted position to an extended position and vice versa perpendicularly to the axis of the girder.

2. Apparatus as in claim **1** further comprising a station for the horizontal alignment of drilling rods, said station having means for moving each rod over a precise distance from the axis of said girder when the latter is in the horizontal position, and means for moving the end of each rod perpendicularly with respect to a precise point on the axis of the girder, said girder being pivoted on said derrick in such a position that the tipping of the girder to a vertical position, bearing a rod picked up by said grasping means, in the retracted position, moves said rod into a position spaced from said pulley block when it is in said offset position, said grasping means serving to move the rod to the extended position in alignment with the drilling axis.

3. Apparatus as in claim **1** wherein said grasping means is movable in a direction parallel to said girder axis, and means are provided for moving said grasping means in said direction.

4. Apparatus as in claim **1** wherein said pulley block moving means comprises a slide bar rigidly mounted on said support along which the pulley block can move, and a jack, said jack moving said pulley block between said offset position and a second position in which the axis of said pulley block coincides with the drilling axis.

5. Apparatus as claimed in claim **1** wherein said girder further comprises a means for hooking onto its upper portion cooperating with a locking device attached to said derrick, and a lower stop for supporting heavy tubular elements, the position of said stop on said girder being such that, when the girder is pivoted to the vertical position, said stop is at a small vertical distance from a drilling joint adapted to receive said elements.

6. Apparatus as in claim **5** wherein each of said pulley block, said supporting means, said grasping means and said girder is associated with two members, each of which transmits a control signal in response to the movement of said pulley block, supporting means, grasping means and girder to their extreme positions, and wherein similar transmitter members are provided on said derrick arms and said elevator collar and are responsive to the movement of said arms and said collar to their extreme positions.

7. Apparatus as in claim **6** wherein:

a. the control signal transmission member, associated with the opening of said elevator collar, is connected to control means for movement of said pulley block to said offset position;

b. the control signal transmission member, associated with the control means for the movement of the pulley block to said second position is connected to the means for the control of the closing of said elevator collar;

c. the control signal transmission member, associated with the extension of said arms of the derrick, is connected to the means for the control of the closing of nippers on the arms of the derrick;

d. the control signal transmission member associated with the opening of said nippers on said derrick arms, is connected to the means for the control of the withdrawal of the derrick arms; and

e. a triggering member, maneuvered by the operator, is provided for the individual control of opening and closing of said collar of the elevator, the movement of said pulley block between said offset and second positions, the pivotal movement of said girder, the movement of said girder supporting and grasping means, the extension and return of said arms of the derrick, the opening and closing of said nippers on the derrick arms, and the locking and unlocking of said girder in the vertical position.

8. Apparatus as in claim **7** further comprising a general switch and a series of switching members connected to said general switch and to four lines inserted in control connections for the movable components of said apparatus, said general switch providing for the control of each group of associated components independent of each other when it is switched into a first position, said general switch connecting the component controls and the associated component groups with each other, so as to assure the cyclic and automatic performance of the operations of raising the rods or lowering the rods, depending on whether it is switched to a second or a third position, and said general switch rendering each component control of one and the same group of components independent when it is switched to a fourth position.

9. Apparatus as in claim **8** wherein a portion of said grasping means, mounted on said girder, is used exclusively for holding pipes and drill collars, and another portion thereof is used for holding drilling rods, control means are provided for said portions of said grasping means, and switching means is connected to said control means to provide for the independent operation of said portions of said grasping means.

* * * * *