

[54] **TELESCOPIC CRANE JIB**

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[22] Filed: **Sept. 25, 1973**

[21] Appl. No.: **400,652**

[30] **Foreign Application Priority Data**

Sept. 28, 1972 Germany..... 2247491
Oct. 7, 1972 Germany..... 2249309

[52] U.S. Cl..... **212/64, 212/33, 212/57**

[51] Int. Cl..... **B66c 23/02**

[58] Field of Search..... 212/64, 33; 187/57, 9

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Assistant Examiner—R. Johnson

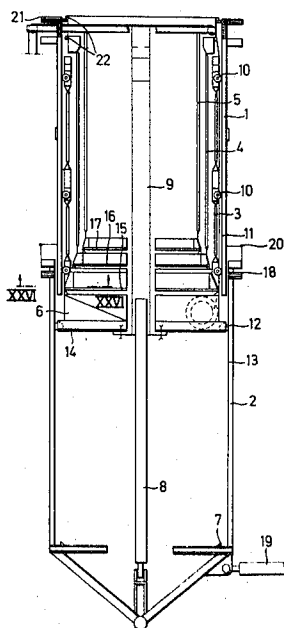
Attorney, Agent, or Firm—Toren, McGeedy and Stanger

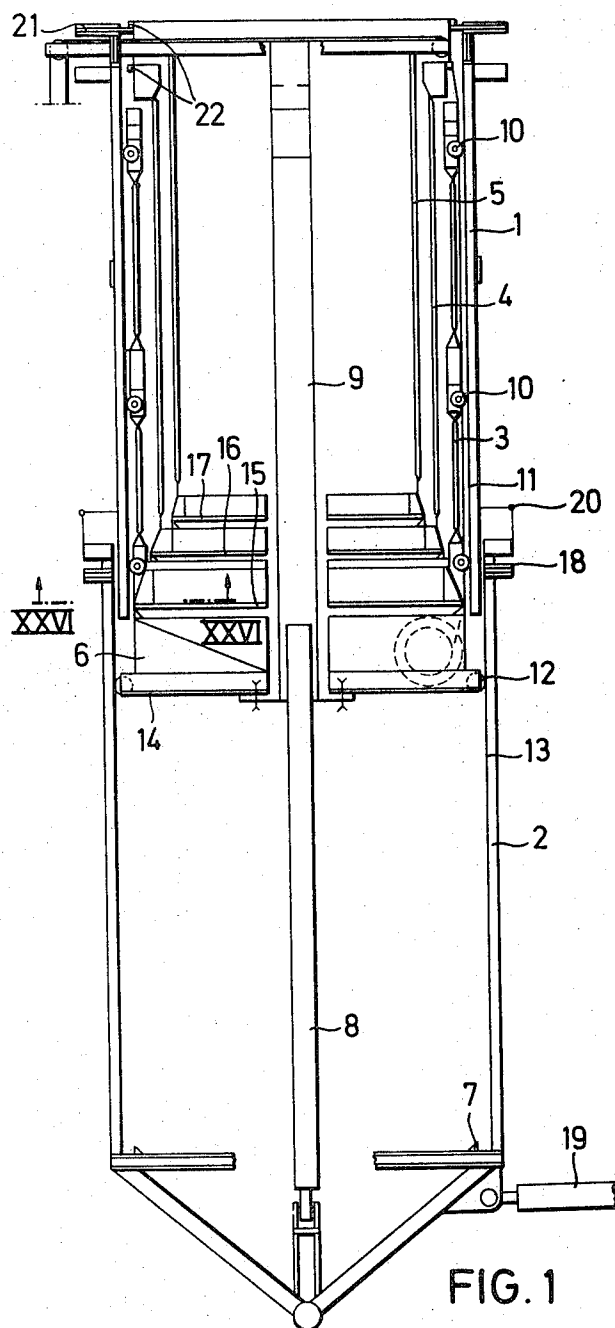
[57] **ABSTRACT**

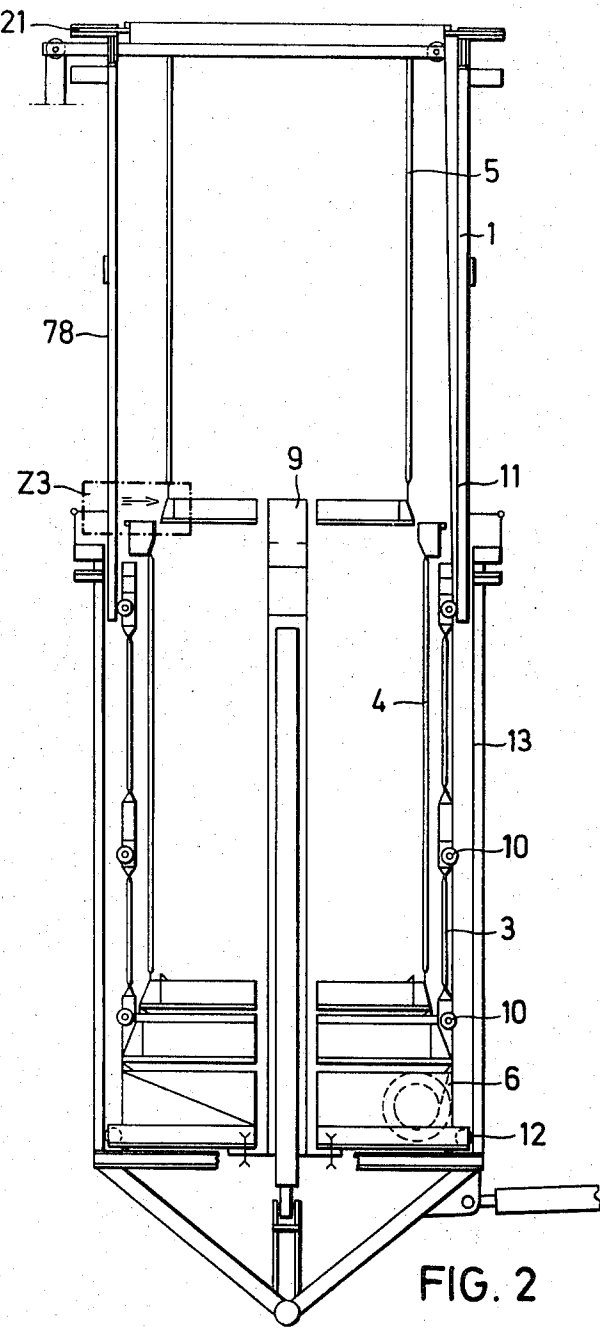
A telescopic crane jib comprises a number of telescopic parts which can be extended and locked end to

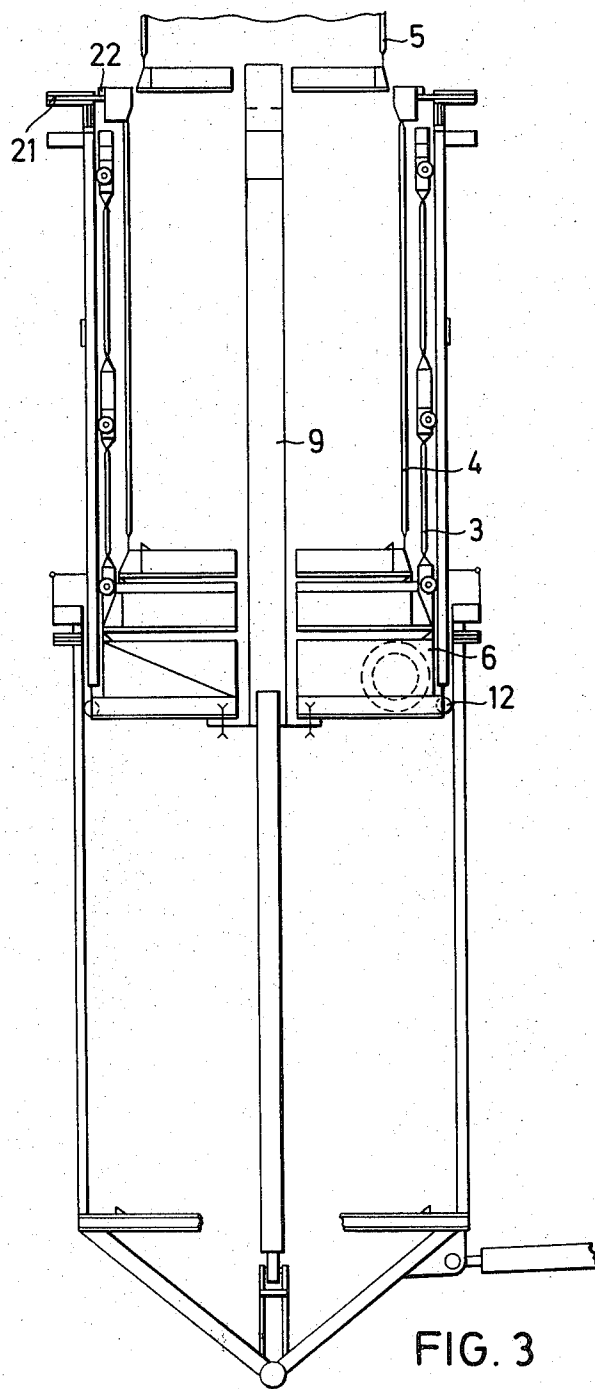
end without substantial overlap. The parts are extended and retracted when the jib is vertical by means of a fluid pressure operated cylinder whose piston rod extends downwards from the cylinder and is fixed to the lower end of a housing which surrounds the telescopic parts in their contracted state. The housing is in fact in two telescopic parts for ease of transport, but whenever the jib is to be used the housing is extended to its active length of substantially twice that of each of the telescopic jib parts. The telescoping cylinder acts on the telescopic jib parts through a supporting carrier which is fixed on the lower end of the cylinder below the telescopic parts and which is arranged to engage guide surfaces within the lower portion of the housing. In extending the jib the cylinder is raised to lift the contracted telescopic parts so that a catch mechanism at the top of a housing engages and holds the upper end of the upper telescopic part. The cylinder is then lowered taking with it the other telescopic parts. In the lower position the lower end of the upper telescopic part can be locked to the upper end of the next telescopic part by means of a locking mechanism comprising a bolt housed in the lower end of the upper part and arranged to engage in a bore in the next part. The catch mechanism is released and the cylinder is again raised, pushing the extended upper part of the housing until the upper end of the next part engages the catch mechanism. The process is repeated until the lowest telescopic part is raised into the upper portion of the housing. The cylinder and its supporting carrier are then lowered on their own, and means is provided for connecting the upper end of the cylinder with the lower end of the lower telescopic part so that the cylinder can be again raised to extend the telescopic parts further from the housing.

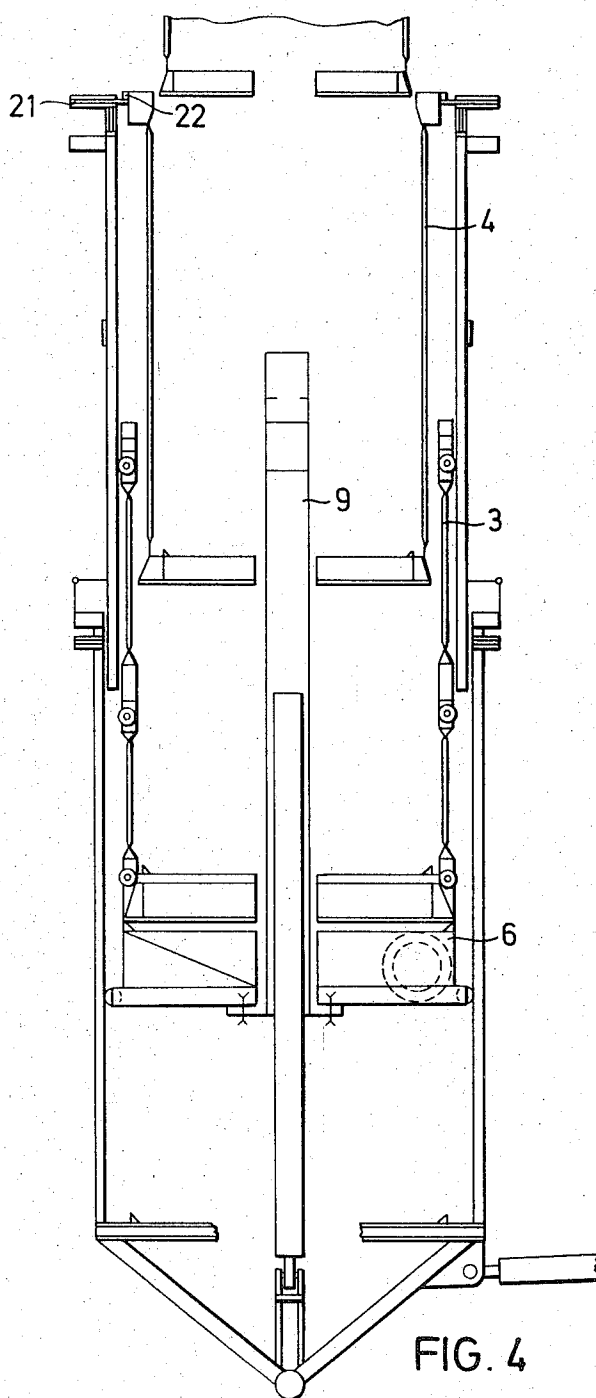
31 Claims, 28 Drawing Figures

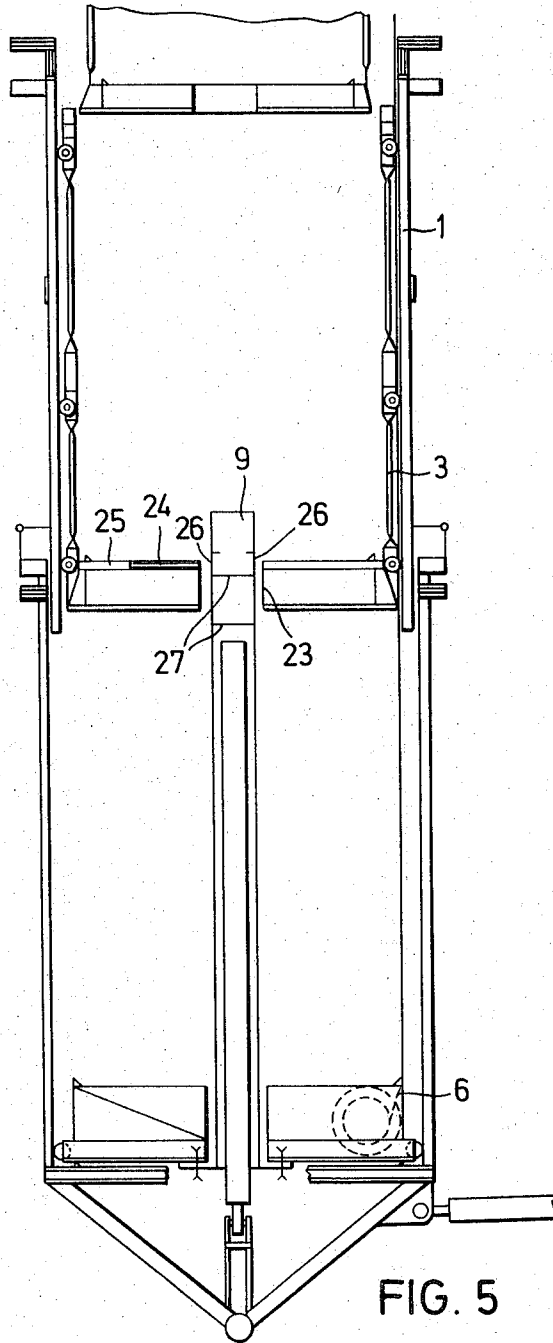


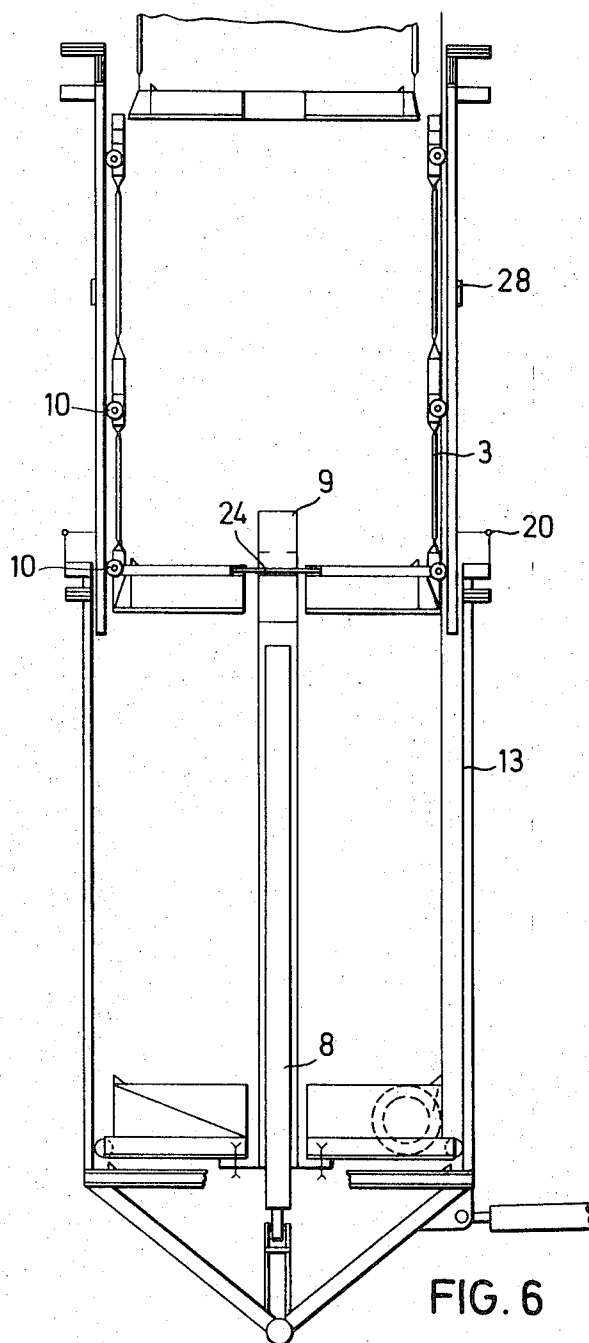


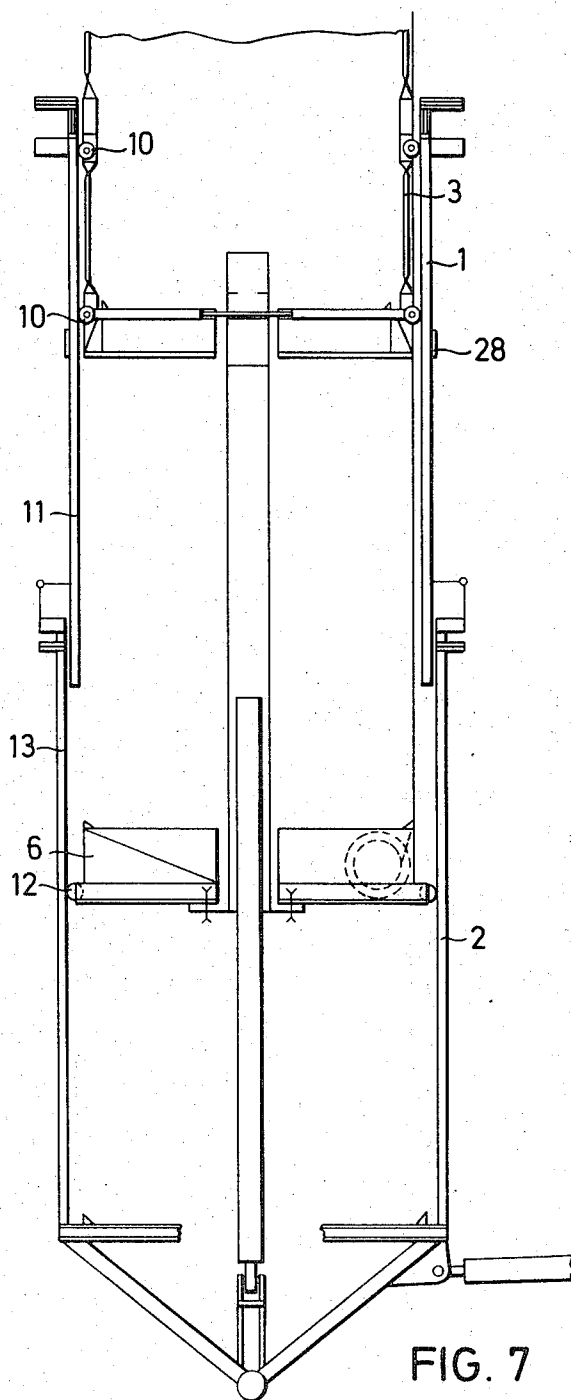












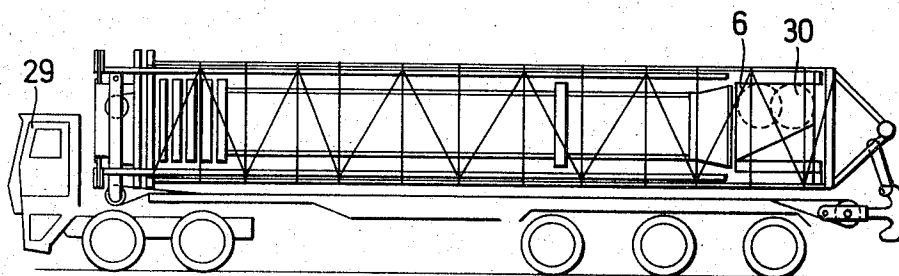


FIG. 8

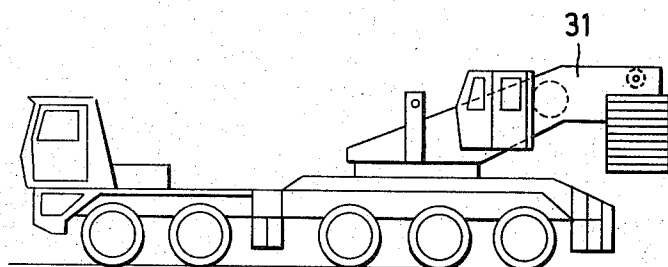


FIG. 9

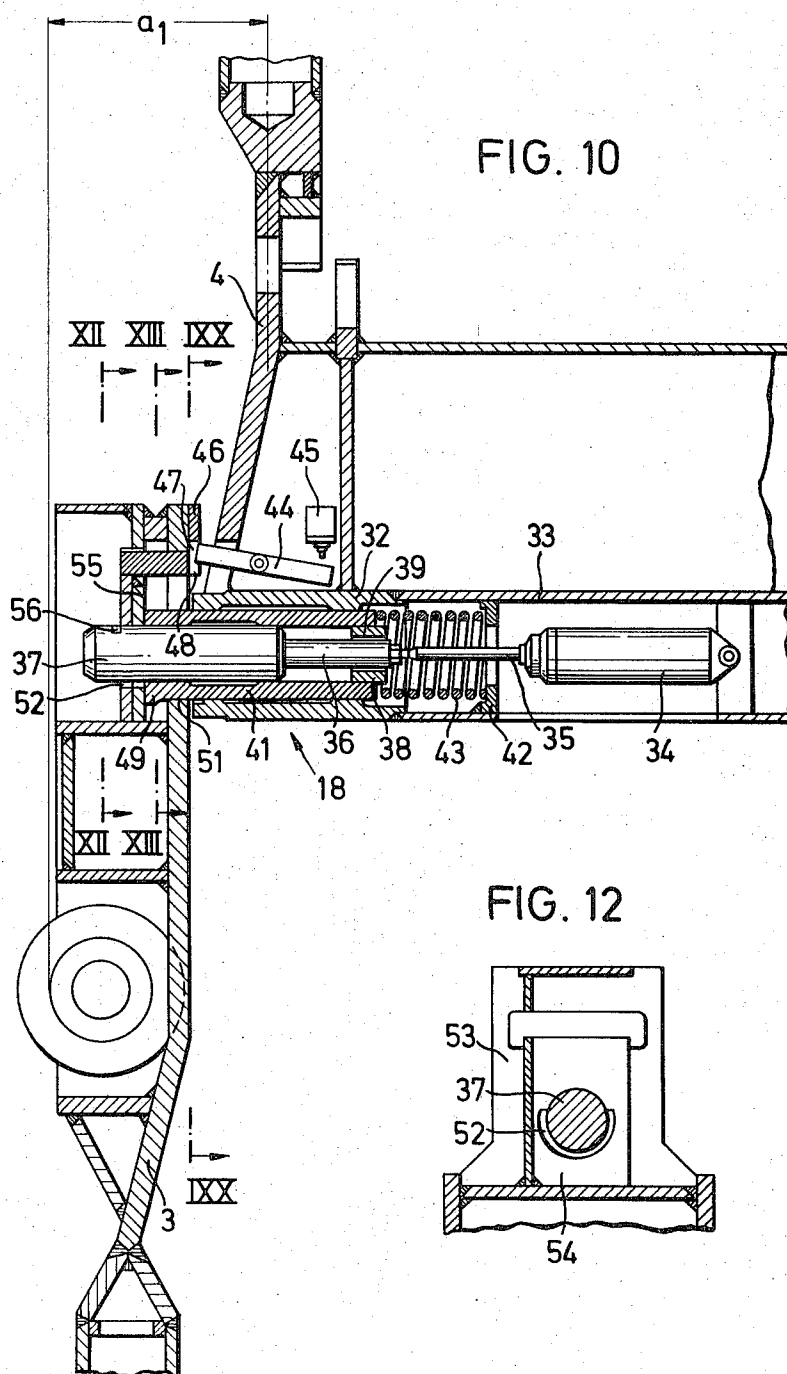


FIG. 11

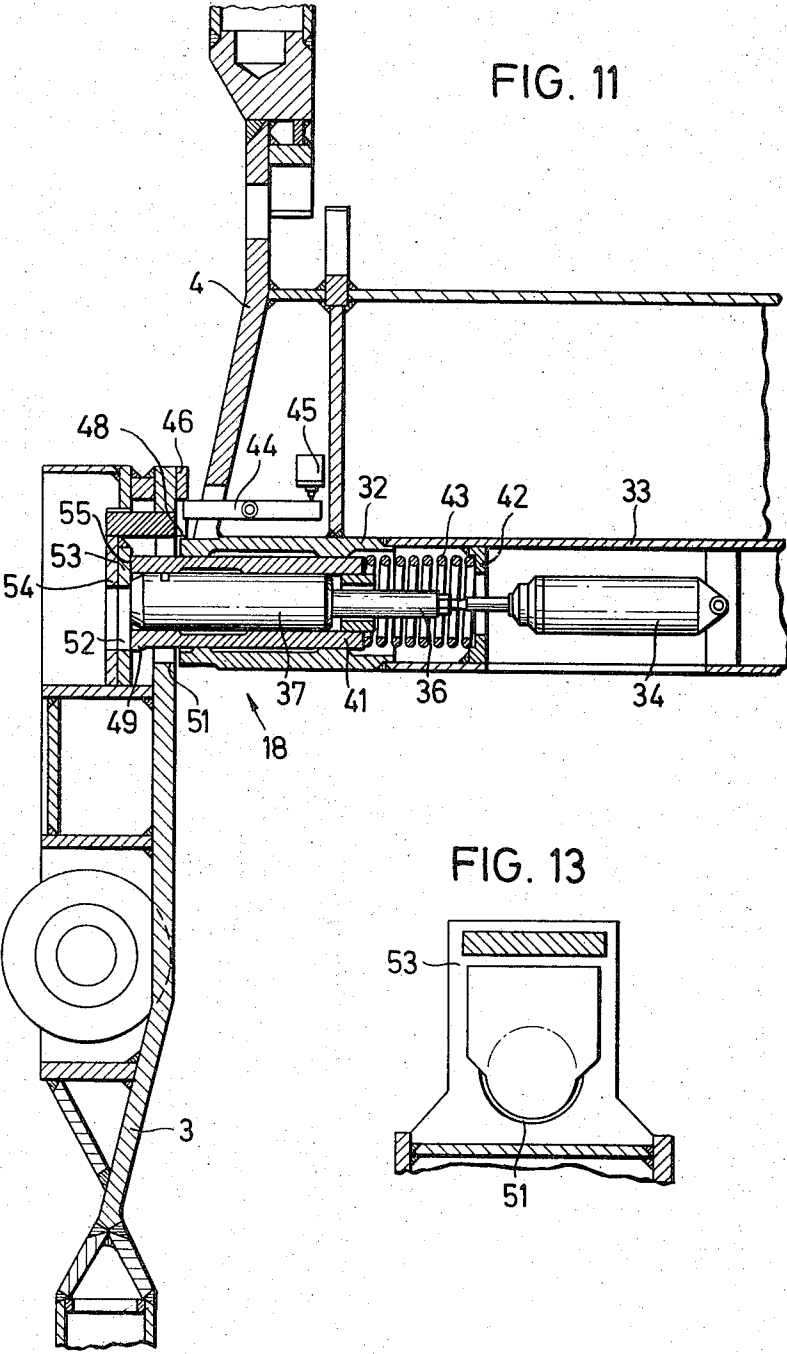
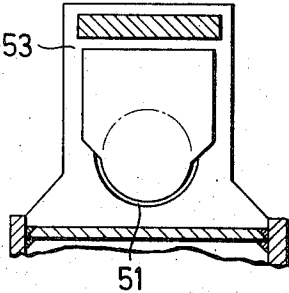


FIG. 13



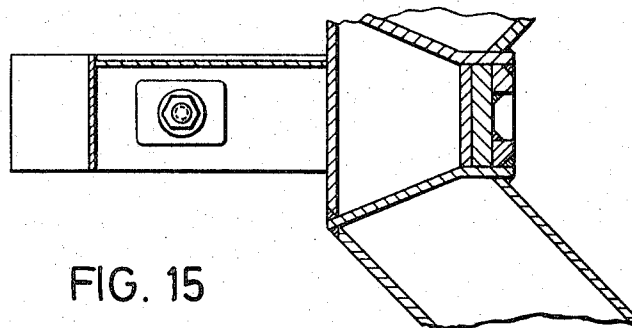
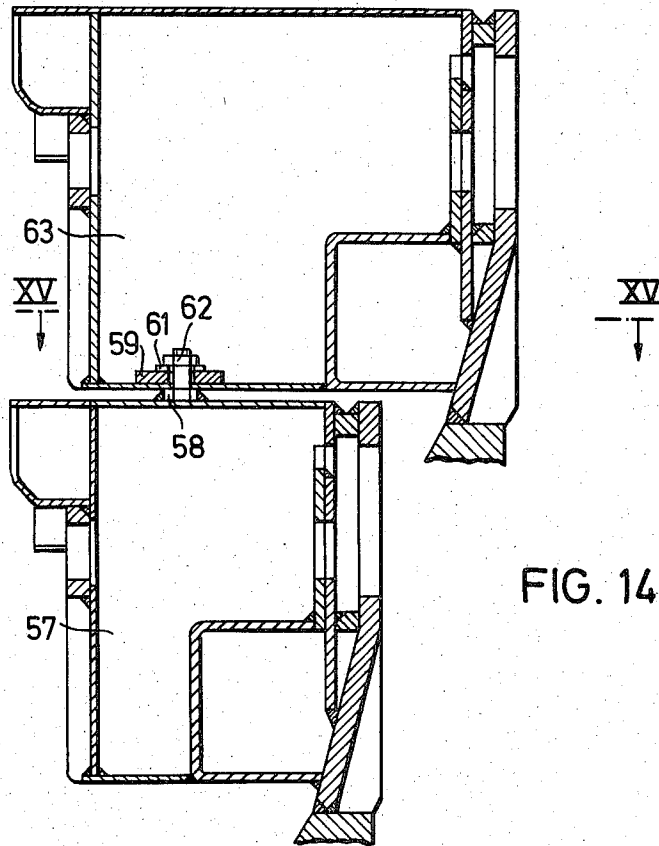


FIG. 16

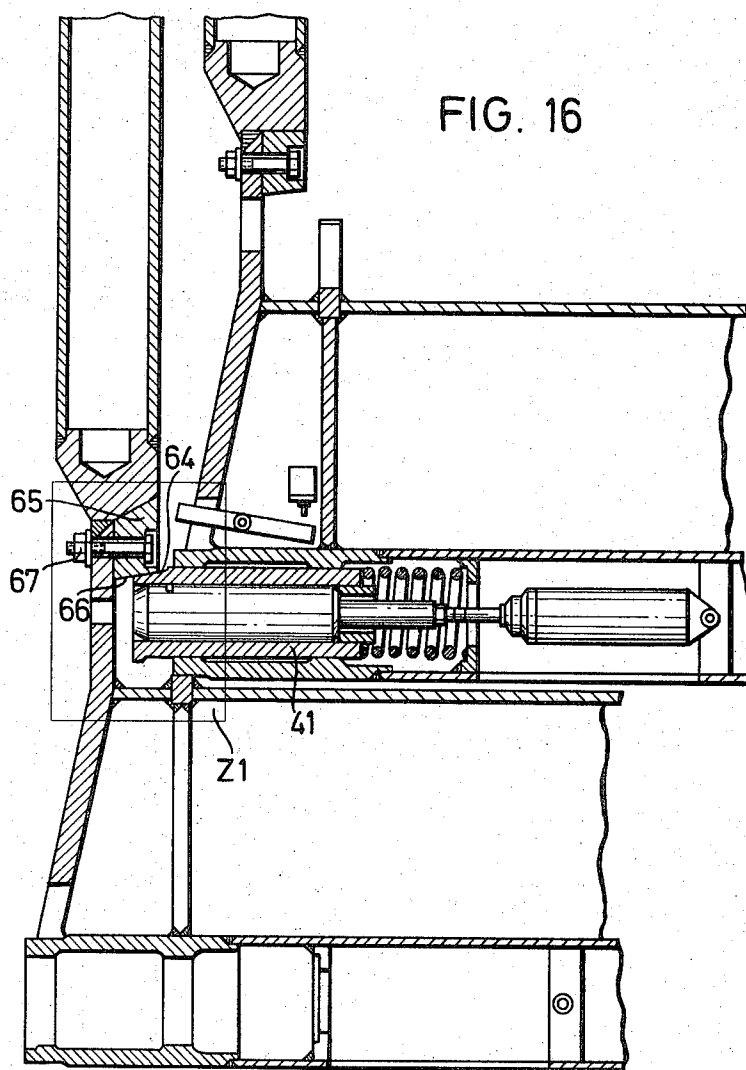
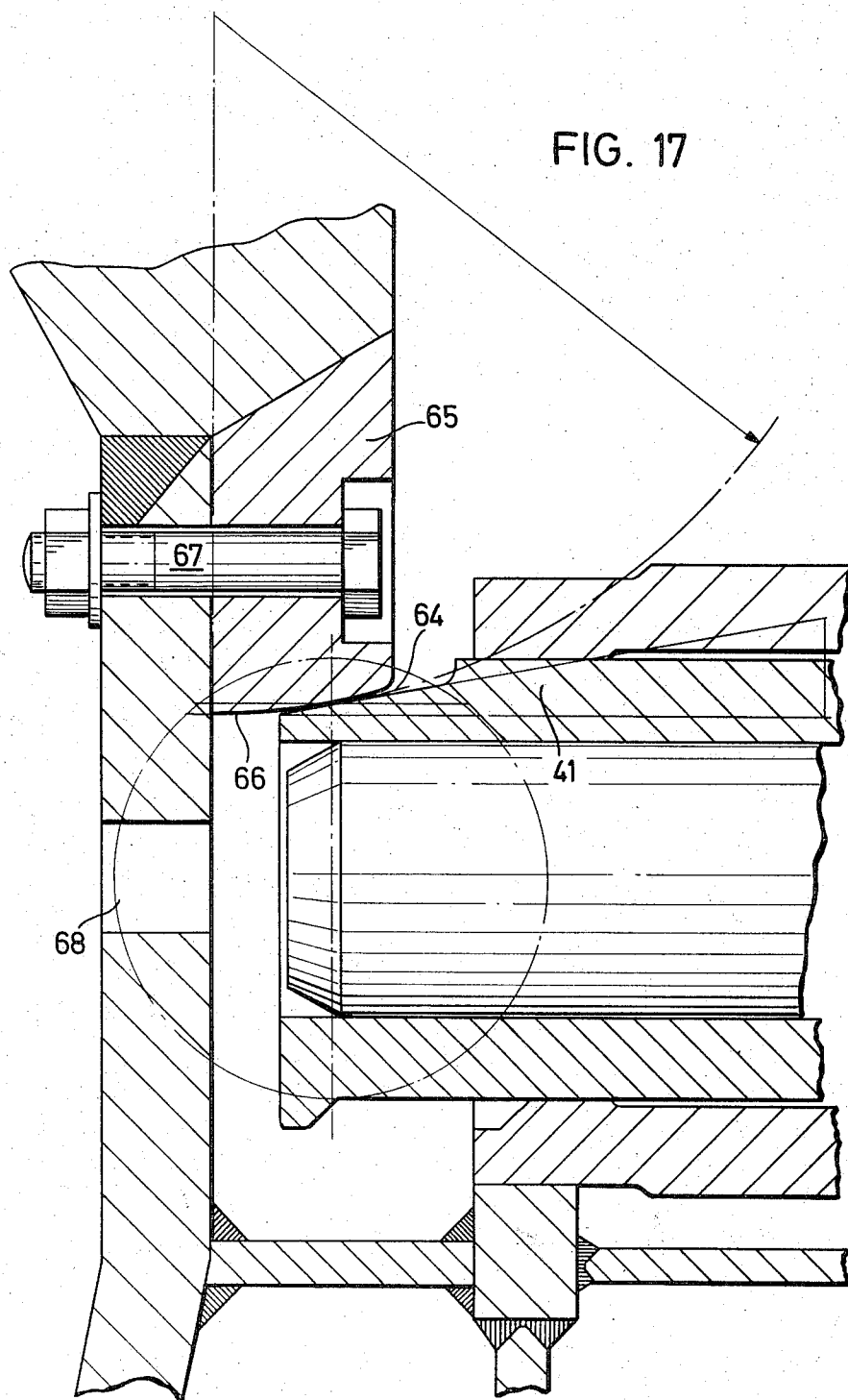
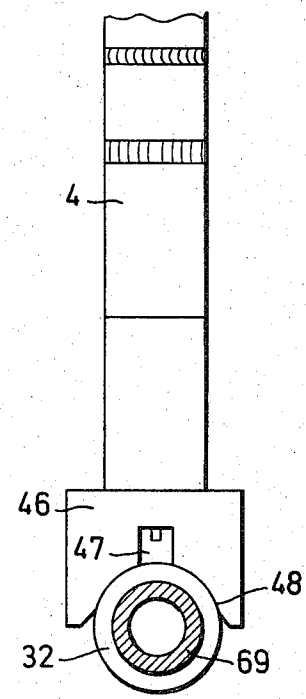
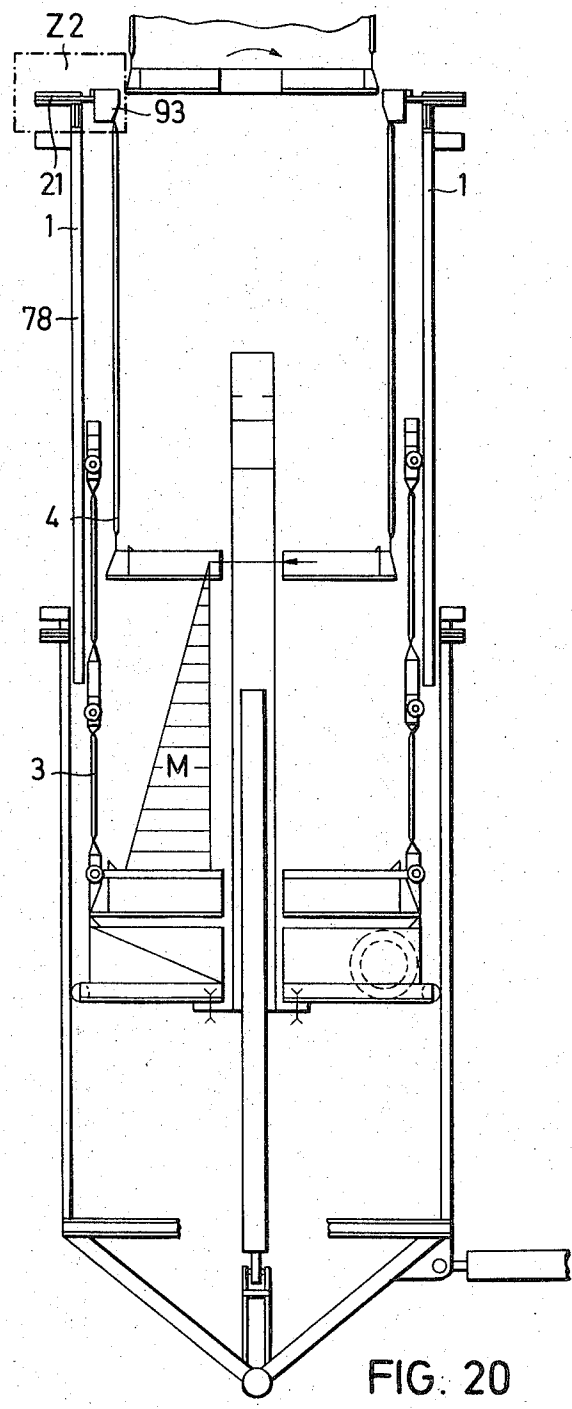


FIG. 17





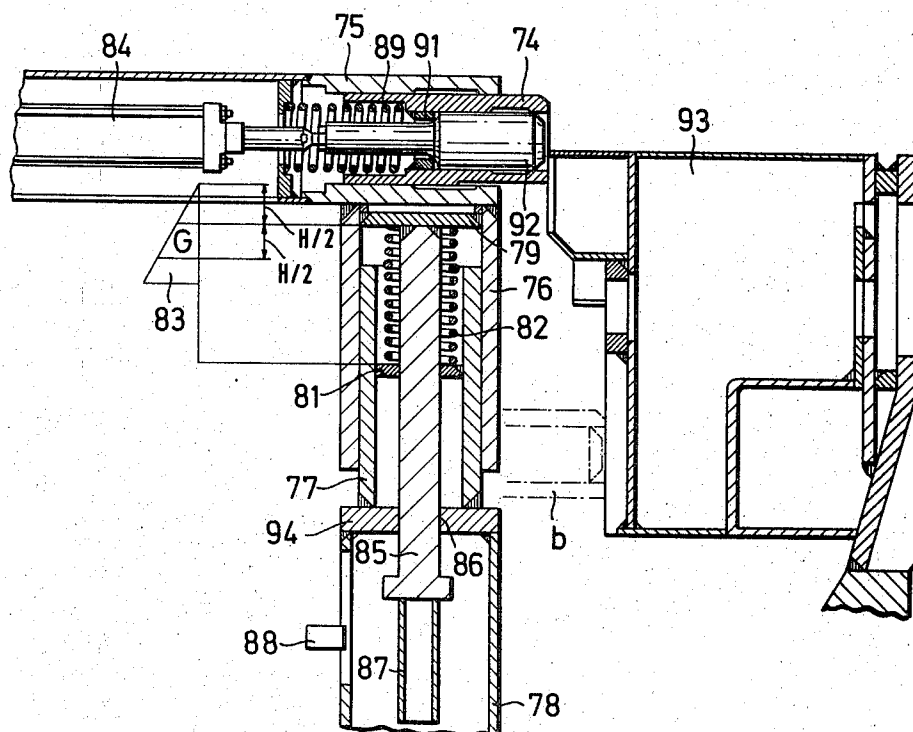
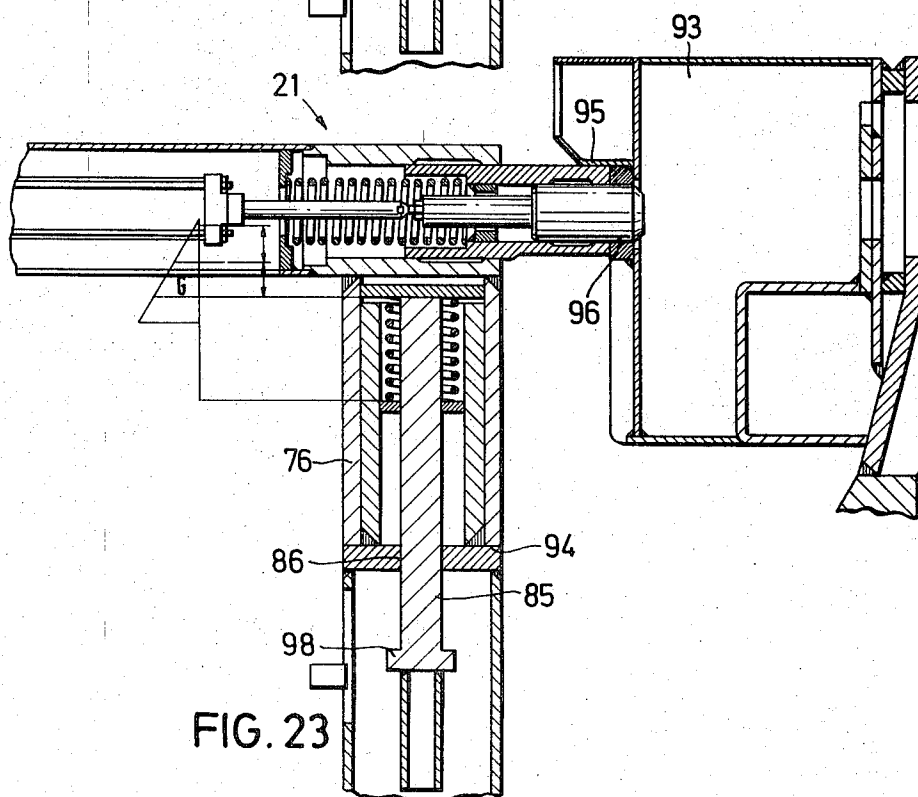
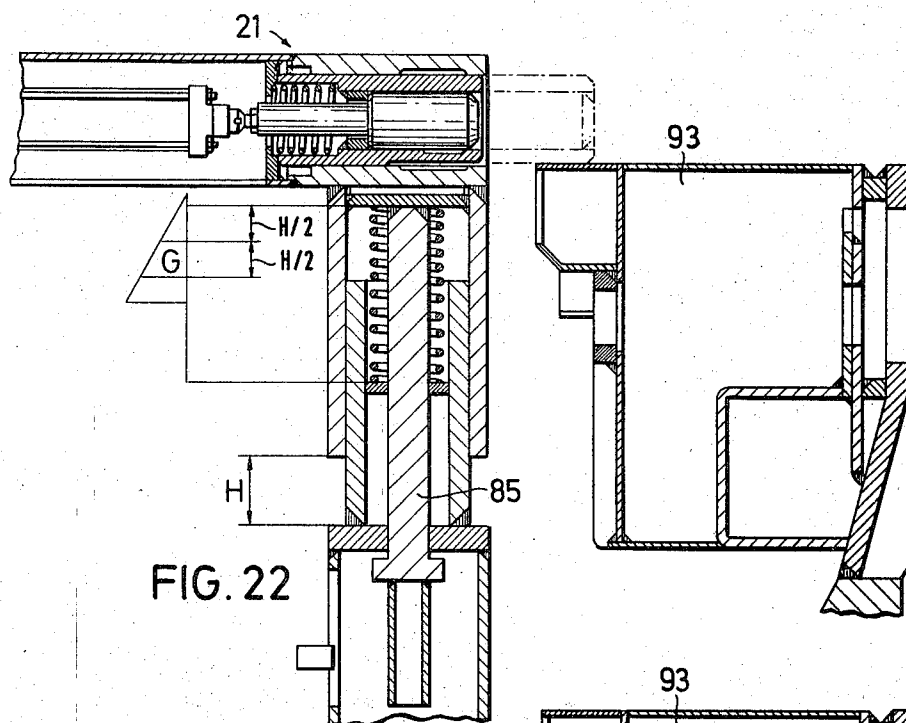


FIG. 21



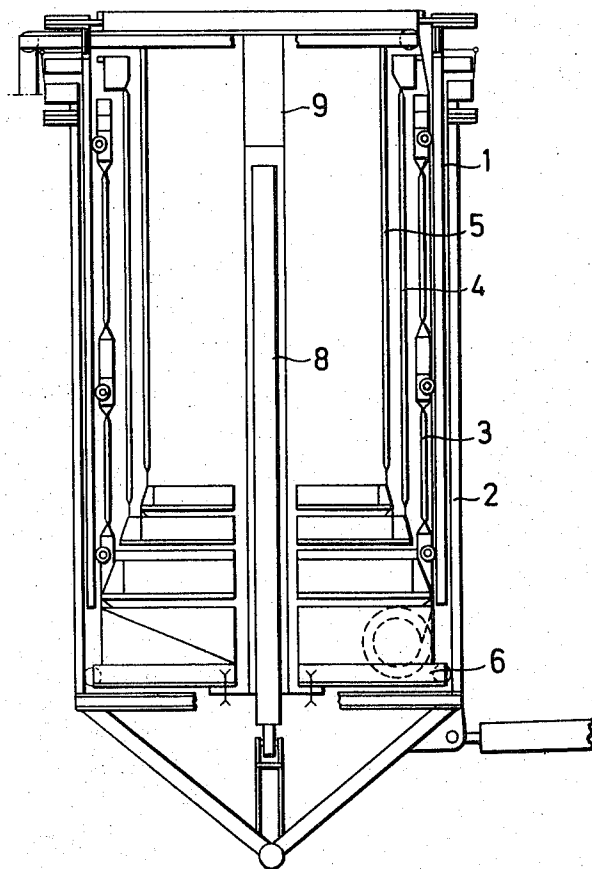


FIG. 24

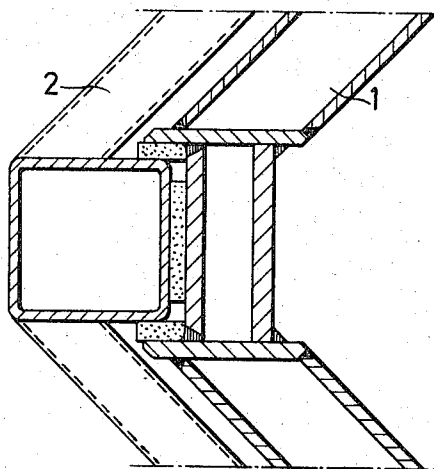
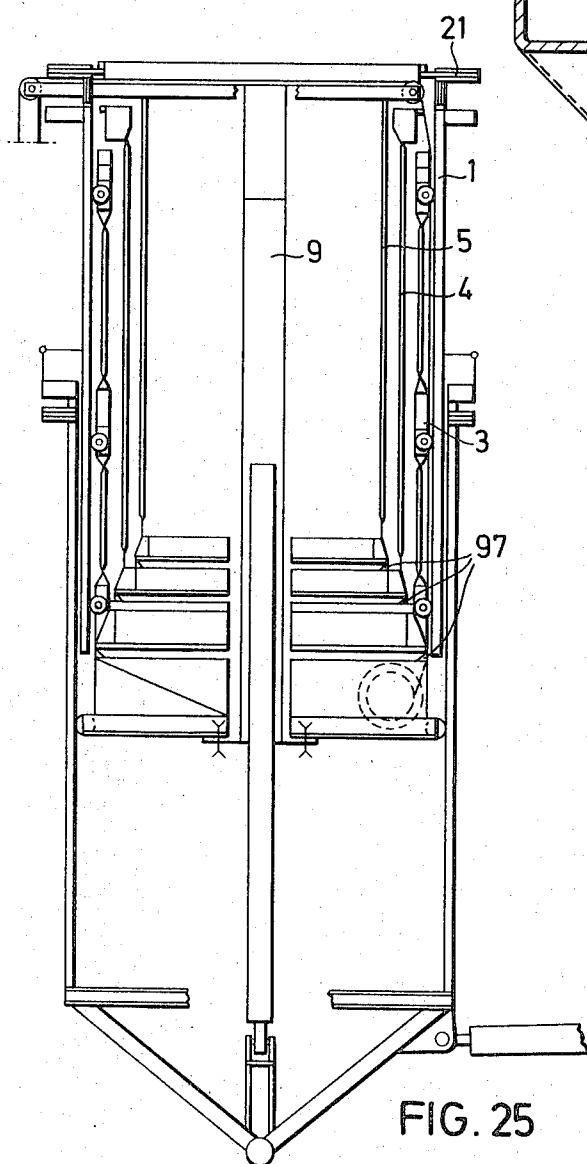


FIG. 27

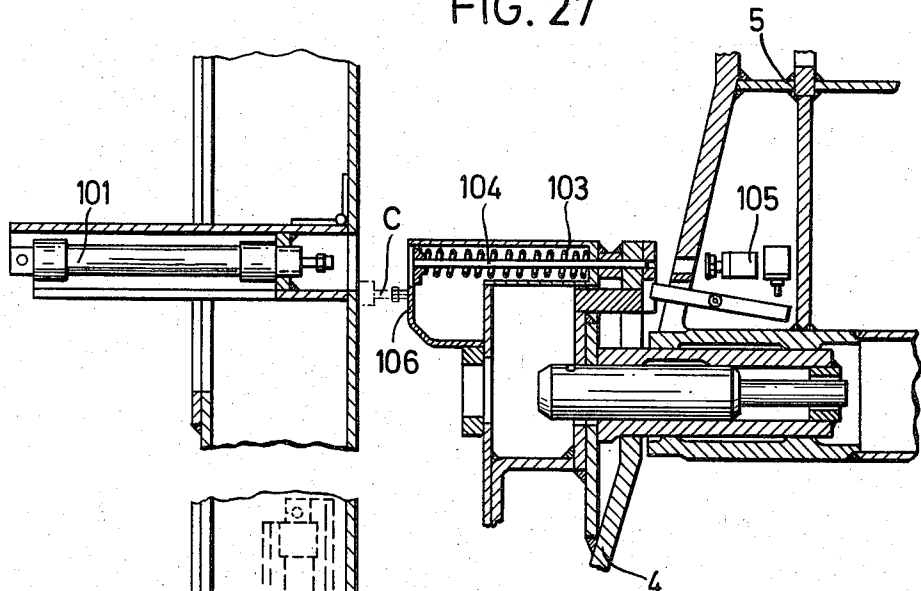
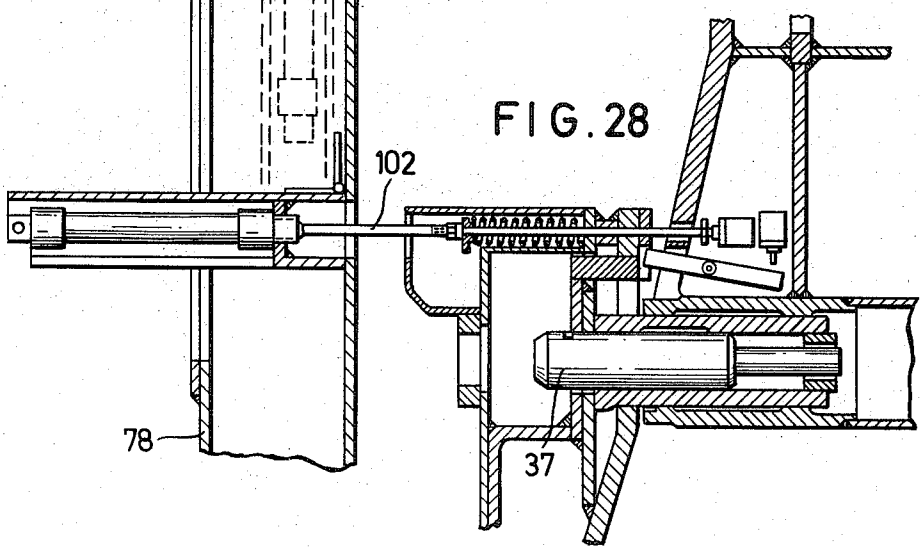


FIG. 28



TELESCOPIC CRANE JIB

The present invention relates to telescopic crane jibs of the kind comprising a number of telescopic parts, means for extending and retracting the parts with the longitudinal axis of the jib at least substantially vertical, locking means situated at the ends of the telescopic parts for locking them together end to end when the parts are extended, and a jib housing which surrounds the telescopic parts when they are retracted.

A crane jib of this kind is described and claimed in our U.S. Patent Application Ser. No. 225,566. In this earlier proposal, in order to extend the telescoped telescopic parts, the parts are first raised in the telescoped state by a single-acting power cylinder, the piston rod of which extends downwards from the cylinder and has its lower end fixed in the jib housing. The crane-jib housing, which is at least twice as long as each telescopic part, is provided at its upper end with a releasable catch which prevents a backward motion of the extended telescopic parts. With this arrangement, the dead weight of the telescopic parts is utilized in their extension and retraction. In extension, after the telescoped parts have been raised, the catch grasps the particular telescopic part to be extended while the other telescopic parts descent into the initial position as a result of their own weight after admission of fluid to the power cylinder is terminated. The extended telescopic part is then locked to the next part, and the procedure repeated till all the parts have been extended and locked.

The lower end of the power cylinder is connected to the lowest telescopic part and hence satisfactory use of the length of the crane-jib housing is only possible with a comparatively long power cylinder; indeed, if the lowest jib part is to be displaced upwards beyond the locking position of the individual telescopic parts, which is situated somewhat above the middle of the housing, in order to obtain as long as length of jib as possible, the length of the power cylinder must be considerably greater than the length actually necessary for the telescoping of the individual jib parts.

Also in the earlier proposal, a locking bolt with a power cylinder and an appropriate control is provided in each telescopic jib part for locking two such parts at a time. In addition, the locking means has a guide tube disposed in each telescopic part to receive the locking bolt, while a stop serving as an abutment for the guide tube, as well as a support serving for the resting of the guide bolt, are provided on the adjacent telescopic part. Thus an individual power cylinder and a corresponding is necessary in each case for the adjusting movement of each locking bolt, leading to relatively high expenditure on construction.

Because of the locking bolt and the power cylinder of the lowest telescopic part both have to be accommodated inside the crane-jib housing, a comparatively great reduction in the cross-sectional dimensions of the lowest telescopic part in comparison with the cross-sectional dimensions of the jib housing must be accepted. The reduction in the cross-sectional dimensions of the lowest telescopic part necessarily leads, however, to reduction in the cross-sectional dimensions of all the other telescopic parts because these have to be retracted into the lowest telescopic part. The crane jib loses a considerable amount of carrying capacity as a result.

Furthermore, the crane jib must be arranged so that the total centre of gravity of the extended jib, including any built-on jib extension, does not lie outside the support for the locking bolts, because the locking pawls cannot take up a tilting moment of the parts of the jib which are already extended. Particularly with a long built-on jib extension, the telescopic part to be extended must be supported at its lower end on the hydraulic cylinder provided for the lifting and for guiding the telescopic parts into a position of stable equilibrium. This is tolerable at the beginning of an extending operation, because the hydraulic cylinder is connected to the bottom of the lowest telescopic part so as to be resistant to bending and the supporting force acts below in the vicinity of the bottom. The further the telescopic part is extended, however, the greater becomes the lever arm exerting bending stress on the hydraulic cylinder, and finally the inclination with a high tilting moment is limited by abutment of the telescopic part to be extended against the next following telescopic part. This inclination, however, prevents all the locking bolts from coming to bear against the support during the locking, although this is a prerequisite for satisfactory locking.

Finally, since the length of the jib housing is greater than double the length of a telescopic part, the jib has such a great length in comparison with the telescopic parts when retracted, that it usually has to be dismantled during transport of the crane-jib.

The present invention is concerned with improving generally telescopic crane jibs of the kind described, primarily so that satisfactory utilization of the length of the crane-jib housing is possible without having the power cylinder unduly long.

According to the invention, in a crane jib of the kind described the means for extending and retracting the telescopic parts comprises a fluid pressure operated cylinder which is arranged to move vertically within the housing and which has its lower end located below the lowest telescopic part and guided vertically in a lower portion of the housing. With the power cylinder additionally vertically guided in the lower portion of the crane-jib housing at its lower end independently of the individual jib sections, it is possible, after the extension and locking of the lowest jib part, for the power cylinder to be relieved of load substantially in the middle of the crane-jib housing and so to be able to sink into its lower position under its own weight. Preferably, however, the lower end of the telescoping cylinder is fitted with a supporting carrier on which the telescopic parts rest when they are retracted and which engages the lower portion of the crane-jib housing in guiding vertically the cylinder. The supporting carrier gives additional support to the lower end of the cylinder as well as guidance, and also helps the return of the cylinder to its lowest position.

The length of the jib during use may be shortened for transport purposes if the jib housing comprises two telescopic portions, the upper portion being extended and retracted relative to the lower portion by means of the telescoping cylinder acting on the upper portion through the telescopic parts. The supporting carrier is then guided in a particularly advantageous manner by rollers running on surfaces in the lower portion of the crane-jib housing. This arrangement means that the continuous surface, otherwise necessary, in the jib housing for guiding, usually by rollers, the lowest tele-

scopic part is not necessary. From the lowest position up to the highest locking position, the lowest telescopic part is still adequately guided by being supported on the support carrier despite losing individual contact with the housing in the lower portion in which the width is greater than in the upper portion.

Preferably the jib is provided with means for releasably connecting the upper end of the telescoping cylinder to the lower end of the lowest telescopic part. With this arrangement the lowest telescopic part can be lifted further up in the crane-jib housing, beyond the centre position where the locking of the parts together is effected without the cylinder needing to be very much longer than half the housing height. The releasable connecting means may comprise a bolt which is carried by the lowest telescopic part and which is displaceable transversely to the longitudinal axis of the jib into the cylinder. The bolt may be movably mounted in tubes and be arranged to be displaced by means of a pneumatically operated servo piston.

Since the power cylinder is not only supported through the rollers present on the supporting carrier at its lower end, but also at its upper end through rollers present on the lowest telescopic part, there is a considerable reduction in the unsupported length of the power cylinder-and-piston drive. Since, after the raising of the lowest jib part and its locking to the housing in its uppermost position, only the bending force resulting from dead weight is decisive for the selection of the overlapping between the crane-jib housing and the lowest telescopic part, and this can naturally be kept very low with vertical telescoping.

A further advantageous development of the invention is obtained if the supporting carrier is simultaneously constructed in the form of a carrier member for one or more lifting drums, and possibly their drive members, for the crane hoist. As a result, during the attachment of the telescopic jib to the crane, the complicated removal and replacement of the cabling for the hoist and luffing mechanism of the crane, which is otherwise necessary, can be eliminated. In addition, as in mobile cranes with a complete telescopic jib, a very simple superstructure is possible and the lifting drums no longer need to be accommodated on this.

A simple possibility for the precise alignment of each two telescopic parts to be locked to one another results if the locking means for locking the two parts together end to end comprises a guide tube and a locking bolt which is mounted for displacement therein at the lower end of the upper of the two telescopic parts and which is movable by means of a double-acting fluid pressure operated cylinder, a locking bore in the upper end of the lower telescopic part for receiving the locking bolt, and means on the two parts which cooperate to determine alignment of the locking bolt with the locking bore. In this manner, a telescopic crane jib is obtained with a locking mechanism which is distinguished by a simple and inexpensive construction, because only one power cylinder per locking point is necessary for the adjustment of the locking bolt. In addition, with such an arrangement of the locking mechanism, the cross-sections of all the telescopic parts can be made larger than previously, which leads to a saving in weight or to an increase in the carrying capacity.

Preferably a catch mechanism is disposed at the upper end of the jib housing and comprises a guide tube and a catching bolt which is mounted for displacement

therein and which is movable by means of a double-acting fluid pressure operated cylinder, the upper end of each telescopic part having a catching bore for receiving the catching bolt when cooperating means of the mechanism and the telescopic part engage to determine alignment of the bolt and the bore. This catch mechanism is similar in basic construction to the locking mechanisms between the telescopic parts and enables precise alignment of the telescopic parts to be locked to one another, even with a high tilting moment in the parts of the jib already extended. Thus a telescopic crane jib is obtained having a mechanism which, on the one hand, installed at the lower end of each telescopic part, locks the telescopic jib parts together and, on the other hand, provided at the upper end of the jib housing, serves to secure the telescopic parts to be extended positively against tilting during the extending operation, but likewise to release them positively from the catch during the upward movement so that they can be extended. If the length of the jib is shortened for transport purposes by means of a jib housing which can be telescoped, and the upper portion of which is connected to the power cylinder providing for the telescoping of the jib parts, by means of the jib parts and the catch mechanism provided at the upper end of the jib housing, when the jib housing and the jib parts can be telescoped with the same power cylinder without appreciable additional structural expense. Dismounting of the crane jib from the crane travel unit for transport can be avoided in the majority of cases as a result, and only remains necessary with telescopic jib extensions or with main jibs having very large dimensions.

Insofar as, in a further development of the invention, the catch mechanism disposed at the upper end of the jib housing is preferably displaceable slightly in the vertical direction by the telescopic parts, and there is provided means for controlling operation of the cylinder for moving the catching bolt in dependence upon the vertical position of the catch mechanism relative to the housing, further important advantages result. Greater tilting moments can be taken up as a result of this mechanism, so that the hydraulic cylinder serving as a power drive is kept free of bending moments which develop as a result of the fact that a telescopic part to be extended is supported on the hydraulic cylinder during the extending operation.

Preferably the locking and catching bolts of the locking and catching mechanisms respectively are each surrounded by a sleeve which is axially slidable in the guide tube associated with the bolt and which forms part of the cooperating means for determining alignment of the bolt with its locking or catching bore. Such a construction has the advantage that during the alignment of the telescopic parts, the sleeve is set down on a support on another telescopic part or the housing, and the telescopic part to be extended is thus resting on the support, so that loading from the dead weight of the telescopic part cannot have an unfavourable effect on the adjustment of the locking bolt. It is a further advantage that after complete locking, the locking bolt projects through the bore so as to be clearly visible, which renders possible easy visual checking, for example from a platform on the jib housing.

Preferably each locking and catching bolt has a reduced diameter shank portion at its end adjacent its operating cylinder, and the surrounding sleeve has an end plate with a bore for the passage of the shank portion,

the end plate serving as a stop surface for the bolt. By this means, both the bolt and the sleeve can be brought into the unlocked position by the same power cylinder so that a considerable simplification results in the actuation of the locking members. The sleeve is preferably subject to the action of a compression spring which is disposed between its end plate and the power cylinder. The purpose of this compression spring is to displace the sleeve into its extended locking position. In an advantageous manner, it also saves a separate control during the locking of the telescoped jib sections, because, as a result of the shutting off of the compressed air after termination of the telescoping, the power cylinder no longer holds the locking bolt against the pressure of the spring, but presses the spring against wedge surfaces or convexly arched surfaces in the locking bolt for the transmission of the longitudinal thrust without play. In this manner, tilting of the telescopic parts situated one inside the other is prevented during lowering of the completely telescoped jib. Switching on the compressed air again releases the connection after the raising of the jib and releases the retracted jib parts for the telescoping.

The vertically adjustable catch mechanism at the upper end of the jib housing is movable between a mid-rest position and upper and lower limit positions. When the catch mechanism is in the lower limit position, the bolt with its surrounding sleeve is in an extended position. The adjustable catch mechanism sinks into the lower position under the loading of the telescopic part to be supported. The unlocking of the telescopic parts is then always effected at the same place in the crane-jib housing.

At the unlocking point in the crane-jib housing there may appropriately be an actuating mechanism for displacing a push rod against the pressure of a spring, which enables a sensor to be actuated which initiates the return movement of the locking bolt of the appropriate locking mechanism. The particular advantage of this arrangement lies in the fact that the push rod is only situated opposite the pneumatic cylinder of the actuating mechanism which has to be operated when the telescopic part to be retracted is held at its upper end by the catch mechanism, as desired, at the moment of unlocking.

Embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 shows one example of a telescopic crane jib in accordance with the invention, in a diagrammatic longitudinal section, in which the jib head, the foot of the crane-jib housing and hoist lifting drums are shown offset by 45°;

FIGS. 2 to 7 are views similar to FIG. 1 showing the crane jib in various operational positions;

FIG. 8 shows a dismantled crane jib of a mobile crane in accordance with the invention;

FIG. 9 shows an associated mobile crane superstructure;

FIG. 10 is a partial longitudinal section through the adjacent ends of the two lowest telescopic jib parts of the crane of FIG. 1 illustrating the locking mechanism serving to lock the parts together;

FIG. 11 is a sectional drawing similar to FIG. 10, showing the mechanism in a partially unlocked position;

FIG. 12 is a section on the line XII—XII in FIG. 10;

FIG. 13 is a section on the line XIII—XIII in FIG. 10;

FIG. 14 is a partial section through the upper ends of two telescopic jib parts in their telescoped state;

FIG. 15 is a section on the line XV—XV in FIG. 14;

FIG. 16 is a partial longitudinal section through the lower ends of two telescopic jib parts in their telescoped state;

FIG. 17 shows a detail Z1 from FIG. 16 on an enlarged scale;

FIG. 18 is a view similar to FIG. 10, but of a modified form of the jib in accordance with the invention;

FIG. 19 is a section on the line XIX—XIX of FIGS. 10 and 18;

FIG. 20 is a longitudinal section through a crane jib adapted for telescoping of the housing, showing diagrammatically the housing extended and the retraction of the telescopic jib parts;

FIG. 21 shows a detail Z2 from FIG. 20, illustrating the catch mechanism at the upper end of the housing in a mid-way rest position;

FIG. 22 is a view similar to FIG. 21 showing the catch mechanism in a different operative position;

FIG. 23 is a view similar to FIGS. 21 and 22 showing the catch mechanism in a further operative position;

FIG. 24 shows the crane jib of FIG. 20 with the jib parts and the housing all retracted;

FIG. 25 shows the same jib during the extension or retraction of the housing;

FIG. 26 is a section on the line XXVI—XXVI in FIG. 1; and,

FIGS. 27 and 28 show a detail Z3 from FIG. 2 illustrating a device serving to unlock adjacent telescopic jib parts.

The telescopic crane jib shown in FIG. 1 comprises a jib housing having an upper portion 1 and a lower portion 2 which can be fitted telescopically one inside the other, and three telescopic parts 3, 4 and 5 which have a square cross-section matching the upper portion 1 of the crane-jib housing and which consist of a tubular framework structure. Below the bottom telescopic part 3 is a supporting carrier 6, the lowest possible position of which is in the lower region of the lower portion 2 of the jib housing and is limited by stops 7. The telescopic parts 3, 4 and 5 and the supporting carrier 6 are displaced by means of a single-acting fluid pressure operated cylinder-and-piston drive, of which the piston rod 8 is secured to the bottom of the lower portion 2 of the crane-jib housing and the cylinder 9 is secured in a bending-resistant manner to the supporting carrier 6. The telescopic part 3 is guided by rollers 10 which run on surfaces 11 in the upper portion 1 of the crane-jib housing, and the supporting carrier 6 is guided by rollers 12 which run on surfaces 13 in the lower portion 2 of the crane-jib housing. With the telescopic parts 3, 4 and 5 retracted so that their bottoms 15, 16, 17 rest one on another and on the supporting carrier 6, the application of power by the power cylinder 9 at the bottom 14 of the supporting carrier 6 will raise the telescopic parts 3, 4 and 5 to the position shown in FIG. 1. The telescopic parts 3, 4 and 5 have substantially the same length as each other, which is less than half as long as the extended length of the jib housing, i.e. the combined length of the upper and lower portions 1 and

2 of the crane-jib housing, when they are connected to one another by a locking mechanism 18 in the extended state. With an appropriate stroke of the power cylinder 9, the extension of the crane jib is effected in the vertical position by repeated actuation of the power cylinder 9 and locking together of the individual telescopic parts 3, 4 and 5 as will be described later.

For extension and retraction of the crane jib, the jib is brought into a vertical position by a power cylinder 19 and locked. The locking and unlocking of the telescopic parts 3, 4 and 5, as necessary, is effected above a platform 20, enabling utilization of the length of the individual telescopic parts 3, 4 and 5 to the full. Locking mechanisms which are described in more detail below are disposed substantially at the height of the platform 20. At the upper end of the upper portion 1 of the crane-jib housing there are provided catch mechanisms 21 with which supports 22 disposed at the upper end of each of the telescopic parts 3, 4 and 5 can cooperate.

After the crane jib has been raised into its vertical position as shown in FIG. 1, the telescopic parts 3, 4 and the supporting carrier 6 are lowered into their lowest position by venting the power cylinder 9, leaving the upper part 5 held by the catch mechanisms 21. Although the lower rollers 10 of the telescopic part 3 lose their contact with the guiding surfaces 11 in the upper portion 1 of the crane-jib housing during the downward movement, the telescopic part 3 is seated on the supporting carrier 6 and is therefore supported at its lower end by the rollers 12 of the supporting carrier 6 running on the surfaces 13 of the lower portion 2 of the crane-jib housing. The telescopic parts 4 and 5 are then locked together, and the relative positions of the individual telescopic parts and of the supporting carrier at this stage are illustrated in FIG. 2.

Then the power cylinder 9, which is preferably hydraulic, is pressured so that it raises the supporting carrier 6, and hence the still telescoped telescopic parts 3, 4 and the extended part 5 locked to the part 4, until the middle telescopic part 4 is situated with its supports 22 engaged with the catch mechanisms 21 as shown in FIG. 3. If the power cylinder 9 is then vented, the middle telescopic part 4 is prevented from sinking by the catch mechanism 21 and the supports 22, and therefore it is held at the top of the jib housing in the position illustrated in FIG. 4 while the telescopic part 3 together with the supporting carrier 6 descend under their own weight back towards the lowest position illustrated in FIG. 2. In this position, the part 4 is extended from the part 3 and is locked at its lower end to the upper end of the part 3.

Then the extended and locked telescopic parts 3, 4 and 5 are raised again, carried on the supporting carrier 6, by means of the power cylinder 9, until the telescopic part 3 reaches the position shown in FIG. 5, at which point the telescopic part 3 is locked to the upper portion 1 of the jib housing. After this, the power cylinder 9 is vented and only the supporting carrier 6 returns to the bottom of the jib housing, as is illustrated in FIG. 5.

When the supporting carrier 6 and the power cylinder 9 are in this position, a locking bolt 24, which is adjustable in guide tubes 25 by means of a pneumatically powered piston which is not illustrated, is moved through a slot 26 in the upper end 27 of the power cylinder 9 which extends through a guide bore 23 in the

telescopic part 3, as shown in FIG. 6. If the power cylinder 9 is then again subjected to pressure, and the locking of the telescopic part 3 to the upper portion 1 of the crane-jib housing has been released, the telescopic part 3 is raised at the upper end of the cylinder 9 due to the cooperation of the locking bolt 24 with the part 3 and the cylinder 9. The telescopic part 3 is raised upwards beyond its initial locking position on the upper portion 1 of the crane-jib housing, which is situated at the height of the platform 20, substantially to within the region of a frame 28, as shown in FIG. 7. In this raising, the rollers 12 of the supporting carrier 6 move upwards on the guiding surfaces 13 and the telescopic part 3 is guided by its lower guide rollers 10 in the upper portion 1 of the crane-jib housing. The jib part 3 is then again locked to the upper portion 1 of the crane-jib housing, and in this position the jib is in its maximum extended state. The slight overlapping which is retained between the telescopic part 3 and the upper portion 1 of the crane-jib housing, is sufficient to be able to take up effectively any bending moments which may exist.

As can be seen from FIG. 8, in which the crane jib is shown dismantled and mounted on a vehicle 29, the supporting carrier 6 is constructed simultaneously as a carrier for one or more lifting drums 30 and their drive members. This arrangement of the lifting drums and their drive members on the supporting carrier 6 has the advantage that when the telescopic jib is dismantled and during its subsequent assembly where it is to be used, the otherwise complicated removal and replacement of the cabling for the hoist mechanism of the crane becomes unnecessary.

The arrangement of the lifting drums on the supporting carrier 6 also has the further advantage that — as can be seen from FIG. 9 — the superstructure 31 of the mobile crane can be considerably simpler in construction because — in contrast to previous constructions — the lifting drums no longer have to be accommodated by the superstructure 31.

In FIGS. 10 and 11, sections of the lowest telescopic part 3 and of the middle telescopic part 4 are illustrated in detail to show the mechanism 18 by which the two parts are locked together when extended. The locking mechanism 18 includes a guide tube 32 which is secured to the middle telescopic part 4 and welded onto which is an extension tube 33. Mounted inside the extension tube 33 is a double-acting power cylinder 34 operated by fluid under pressure, the piston rod 35 of which is connected to a reduced diameter portion of the shank 36 of a locking bolt 37. The shank 36 of the locking bolt 37 extends through a bore 38 in the welded-in end 39 of a locking sleeve 41. The locking bolt 37 is guided for displacement in the locking sleeve 41. Disposed between the end 39 and a fixed stop 42 inside the extension tube 33 is a compression spring 43 which tends to force the locking sleeve 41 away from the power cylinder 34.

Mounted for pivotal movement on the telescopic part 4, above the guide tube 32, is a double-armed rocker 44, which is arranged to cooperate at one end with a sensor 45 to control the power cylinder 34 and at its other end, in a manner described in more detail below, with a stop 46 on the telescopic part 3. For this purpose, the end of the rocker 44 projects into a slot 47 in the stop 46. Furthermore, the stop has a concave recess 48, which matches part of the periphery of the guide tube 32 and serves as a stop surface for the guide tube

32. At its front end remote from the end 39, the locking sleeve 41 has a nose 49 which can engage behind a member 51 on the telescopic part 3.

As can be seen in particular from FIGS. 10 and 11, the telescopic part 3 has a locking bore 52 which serves to receive the locking bolt 37 and which is provided by a stop plate 53 and a reinforcing plate 54 secured thereto. As can be seen from FIG. 12, the locking bore 52 is widened out to facilitate the introduction of the locking bolt 37 because contact is only necessary at the top of the locking bore 52 in order to take up tensile forces. The stop plate 53 forms a stop surface 55 for the free end of the locking sleeve 41, and sometimes the locking bolt 37, as shown in FIG. 11. The horizontal distance between the telescopic part 3 and the telescopic part 4 is indicated by a_1 in FIG. 10, and is less than half as great as the corresponding distance in the construction described in specification Ser. No. 225,566.

When, after the extension of the telescopic parts 3 and 4, these have reached the position illustrated in FIG. 11, the stop 46 acting on the rocker 44 causes it to engage the sensor 45, which emits a pulse leading to the actuating of the power cylinder 34. The cylinder 34 advances the piston rod 35 and drives the locking bolt 37 towards the left until this bears with its end face against the stop surface 55 of the stop plate 53. At the same time, the locking sleeve 41 is urged by the spring 43 towards the left until this has also come to bear with its end face against the stop surface 55.

The bearing of the guide tube 32 against the concave recess 48 in the stop 46 prevents the telescopic part 4 from being pulled out of the telescopic part 3, but as can be seen from FIG. 11, when the telescopic parts 3 and 4 are in this extreme position, the locking bolt 37 and the locking bore 52 are not in alignment with one another. Thus, before locking of the two parts 3 and 4 occurs, the middle telescopic part 4 must be lowered a little until the lower edge of the locking sleeve 41 comes to bear against a concave locating surface on the member 51, as illustrated in FIG. 13. This determines a precise relative position of the two telescopic parts 3 and 4, in which the locking bolt 37 is precisely aligned with the locking bore 52 so that, on the further application of pressure by the power cylinder 34, the locking bolt 37 slides into the locking bore 52, as illustrated in FIG. 10. In this position, the mechanism 18 locks the parts 3 and 4 axially together.

In case it is desired that accidental release of the parts 3 and 4 should be impossible, there is also, at the front end of the locking bolt 37, a retaining groove 56 in which a locking washer may be inserted.

In order to unlock the telescopic parts 3 and 4, the power cylinder 34 is pressurised to retract the piston rod 35 so that the locking bolt 37 is withdrawn towards the right, provided the retaining groove 56 is clear. After the locking bolt 37 has covered a certain distance it impinges on the end 39 of the locking sleeve 41, and the sleeve 41 is then also withdrawn towards the right by the power cylinder, and in doing so compresses the spring 43. This is only possible, however, when the telescopic part 4 has been raised slightly, i.e. when its own weight is no longer supported on the member 51 of the telescopic part 3 through the locking sleeve 41. Otherwise, the nose 49 engaging behind the member 51 would block the backward movement of the locking sleeve 41.

The longitudinal thrust at the upper ends of the telescopic parts, when these are telescoped one inside the other, is taken up by a simple bolted joint. The simplest embodiment of such a bolted joint is illustrated in FIGS. 14 and 15. It consists of a bolt 58 which is welded onto a supporting arm 57 of the lower of a pair of telescopic parts, with a shim 59, a washer 61 and a nut 62. By means of these members, the supporting arm 57 can be bolted to a supporting arm 63 on the other of the pair of telescopic parts. The bolting of the two supporting arms 57 and 63 can be effected before the assembly of the crane jib on the ground.

The transmission of the longitudinal shearing forces at the lower ends of the telescopic parts is effected as shown in FIG. 16, using the locking sleeve 41 which is provided with a bevel 64 at its top for this purpose. The locking sleeve 41 cooperates with a stop 65 which is situated on the lower of two adjacent telescopic parts and which is provided with a contact surface 66 which is inclined to match the bevel 64 or is arched convexly in one plane, as shown by the detail Z1 from FIG. 16 drawn on a larger scale in FIG. 17. A slight rotation of the locking sleeve 41 in the guide tube 32 brings the bevel 64 to bear over the whole width of the contact surface 66 and, despite offsetting between the stop 65 and the locking sleeve 41, represents a frictional connection which takes up the longitudinal shear. A bolted joint 67 serves to release the stop 65 in the event of the connection jamming and a bore 68 serves for checking. A stroke limiter can also be accommodated therein.

The locking mechanism illustrated in FIGS. 18 and 19 works fundamentally on the same principle as that shown in FIGS. 10 and 11, with the sole difference that the locking sleeve (shown at 41 in FIGS. 10 and 11) is omitted. In the present mechanism the alignment of a locking bolt 69 with a locking bore 71 is effected when a guide tube 32 comes to bear against a concave recess 48 in a stop 46. This construction is simpler but does not have the safety feature that the telescopic part 4 is supported on the telescopic part 3 in such a manner that the nose 49 on the sleeve 41 ensures that the locking can only be released when the telescopic part is raised slightly from the support of the other part 3. The displacement of the locking bolt 69 is likewise effected by means of a double-acting fluid-pressure operated power cylinder 72. The control of the power cylinder 72 is likewise effected through a rocker 44, a sensor 45 and the stop 46.

Mounted at the upper end of the upper portion 1 of the jib housing is a catch mechanism 21 which is used to support the telescopic parts 3, 4 and 5 during the extension and retraction. The mechanism 21 is shown in detail in FIGS. 21, 22 and 23, and differs from the otherwise similar locking mechanism of FIG. 10 in that the mechanism 21 can be displaced a few centimetres in the vertical direction and in that the nose 49 on the locking sleeve 41 is absent.

As can be seen from FIG. 21, a sleeve 76 which is welded onto a guide tube 75 at right angles is mounted for vertical displacement on a guide tube 77 which extends from the chord member 78 of the upper portion 1 of the jib housing. Between a cover 79 in the sleeve 76 and a fixed stop 81 in the guide tube 77 there is a compression spring 82 which holds the locking mechanism 21, without loading, in the position shown in FIG. 21, i.e. substantially at half the height of stroke $H/2$ as illustrated in the spring diagram 83 in which the dis-

tance G corresponds to its own weight. Altogether, four catch mechanisms 21 are provided, situated opposite one another in pairs, and a sliding feature key (not illustrated in FIG. 21) in the guide tube 77 and a groove in the sleeve 76 for example, ensure that their axes are in alignment with the diagonals of the jib housing 1.

Welded onto the cover 79 inside the sleeve 76 is an entrainment bolt 85 which is mounted for sliding movement in a bore 86. A control tube 87 welded onto the entrainment bolt 85 serves the control of a double-acting power cylinder 84 for moving the catching bolt 92. At its end, the control tube 87 has control cams (not illustrated in FIG. 21) which, in the event of a stroke movement, actuate a valve 88, for example through feeler rollers, to cause actuation of the cylinder 84. In the position shown in FIG. 21, both sides of the cylinders 84 are vented so that a compression spring 89 forces the catching sleeve 74 out of its guide tube 75, the catching bolt 92 also being carried within the sleeve 74 by the action of the end 91 welded into the catching sleeve 74. When the catch mechanism 21 is moved upwards by a raised telescopic part 93 engaging under the projecting sleeve 74, the entrainment bolt 85 is also raised (FIG. 22), as a result of which the valve 88 is operated to cause actuation of the power cylinder 84 so as to retract the catching bolt 92 and also pull in the catching sleeve 74 against the pressure of the spring 89. Thus, the telescopic part 93 can be raised further without hindrance. The catching mechanism 21 then sinks by half the height of stroke back to the position shown in FIG. 21, in which the catching sleeve 74 is forced out again by the compression spring 89.

During an extension operation, the telescopic part 93 to be extended is first raised — as described above — until the catching sleeve 74 is in the position *b* shown in chain lines at the bottom in FIG. 21, in relation to the telescopic part 93. Then the telescopic part 93 is displaced downwards onto the sleeve 74, through which the catch mechanism 21 is forced into the lower position shown in FIG. 23, determined by the sleeve 76 coming to rest on a seat 94 on the chord member 78. The catching bolt 92 is aligned with a catching bore 96 by a support 95 having a concave recess which locates on the sleeve 74. The catching bore 96 may be widened out at its top to facilitate the introduction of the bolt because contact is only necessary at the bottom in order to take up tilting forces. The entrainment bolt 85 is likewise in a lowered position, and the operation of the valve 88 in this position causes the cylinder 84 to advance the catching bolt 92 into the bore 96. The tilting moment of the parts of the jib which are already extended is taken up by the catch mechanisms 21 during the whole extension operation and the hydraulic cylinder is thus effectively relieved of the bending moment M (FIG. 20).

The catching is only forcibly released again when, after locking has been effected at the lower end of the telescopic part to be extended, all the parts locked together including the catching mechanisms 21 are raised and the mechanisms 21 reach the upper end position as shown in FIG. 22. The catching mechanisms can be retracted not only by raising them into their upper end position but also by means of pressure on a control button, through a pneumatic valve. This is necessary during the retraction of the telescopic parts, if the support 95 at the upper end of the telescopic parts is not to be

held by the catch mechanism 21. In all cases, the control is preferably effected forcibly by the stroke movements of the catch mechanisms 21. Raising of the catch mechanisms 21 beyond their end position is prevented by a flange 98 on the entrainment bolt 85 engaging the plate 94 containing the guide bore 86.

In the event of failure of the pneumatic controls, the locking and catching mechanisms 18 and 21 can be operated by hand, in a manner not described in detail because the necessary control forces are comparatively small.

FIG. 24 shows, in the vertical position, the crane jib just described, with the upper portion 1 of the jib housing pushed telescopically into the lower portion 2 of the housing. During the telescopic movement of the upper portion 1 of the housing as shown in FIG. 25, the stroke movement of the power cylinder 9 is transmitted through the telescopic parts 3, 4 and 5, situated one inside the other on seats 97, to the upper portion 1 of the jib housing, which is connected to the jib part 5 by the catch mechanisms 21 as shown in FIG. 23. During extension of the upper portion 1 of the crane-jib housing, compressed air is admitted to the power cylinder 84 through a separate supply line, independently of the control valve 88. Thus, the catching bolt 92 is not withdrawn as a result of the lifting of the catch mechanisms 21 and the flanges 98 of the entrainment bolts 85 raises the upper portion 1 of the housing by bearing against the members 94.

In the extended state of the jib housing as shown in FIG. 1, the upper portion 1 and the lower portion 2 are connected to one another by a locking mechanism which can work on the same principle as the locking mechanism for connecting the telescopic parts to one another.

FIG. 26 illustrates the guiding of the upper portion 1 of the jib housing in the lower portion 2 of the jib housing.

The retraction of the upper portion 1 of the housing into the lower portion 2 of the housing is effected in the reverse manner to the extension.

FIGS. 27 and 28 show the detail Z3 of FIG. 2 with a mechanism for unlocking the telescopic parts when they are to be retracted. In FIGS. 27 and 28, the telescopic part 5 is locked to the lower telescopic part 4. The telescopic part 5 is held at its upper end, in accordance with FIG. 2, by the catch mechanisms 21 which are in their lower end position. Each telescopic part is unlocked from the point at which a small pneumatic cylinder of an actuating mechanism 101 is installed for pivoting upwards in the chord member 78 of the upper portion 1 of the jib housing. If a pulse is transmitted to the cylinder from any desired point, then its piston rod 102 extends as shown in FIG. 28, and, through a push rod 104 which is displaceable against the pressure of a spring 103, a sensor 105 is actuated which releases the pulse for the retraction of the locking bolt 37. The travel of the push rod 104 is, of course, limited in a manner not illustrated here so that the sensor 105 is not loaded by the whole pressure of the piston rod 102.

If the telescopic part 5 is not hanging from the catch mechanisms 21, but these are still in their mid-position for example, the piston rod 102 strikes, in the position *c* shown in chain line, against a plate 106. The locking can therefore only be released in the prescribed manner.

It is understood that the invention is not restricted to the number of telescopic parts illustrated in the drawing and described above, but also permits modifications regarding the construction and number of telescopic parts within the scope of the claims. Thus, apart from the telescopic parts 3, 4 and 5, jib extensions can easily be telescoped in the same manner.

I claim:

1. In a telescopic crane jib including a plurality of individual telescopic parts, means for extending and retracting said parts when the longitudinal axis of said jib is at least substantially vertical, locking means for locking said parts positively together when said parts are extended, and a jib housing surrounding said telescopic parts when said parts are retracted, the improvement wherein said means for extending and retracting said telescopic parts is a fluid pressure operated cylinder mounted for vertical movement within said housing and there is means associated with the lower end of said cylinder below the lowest of said telescopic parts for guiding said cylinder vertically in a lower portion of said housing, and said locking means are situated at the ends of said telescopic parts and include means for locking said parts together end to end.

2. A crane jib as claimed in claim 1, wherein said means associated with said lower end of said extending and retracting cylinder comprises a supporting carrier for supporting said telescopic parts when said parts are retracted, and means mounting said supporting carrier to said cylinder, said supporting carrier engaging said lower portion of said housing in vertically guiding said cylinder.

3. A crane jib as claimed in claim 2, wherein said supporting carrier is provided with rollers, and said lower portion of said housing has guide surfaces on which said rollers run in guiding said cylinder.

4. A crane jib as claimed in claim 1, further comprising means for releasably connecting the upper end of said extending and retracting cylinder to the lower end of the lowest of said telescopic parts.

5. A crane jib as claimed in claim 4, wherein said releasable connecting means comprises a connecting bolt, means mounting said bolt on said lowest telescopic part for displacement transverse to the longitudinal axis of said jib, and means on said cylinder for engagement with said bolt when said bolt is displaced.

6. A crane jib as claimed in claim 5, wherein said means mounting said bolt comprises a tube receiving said bolt and having its axis transverse to the longitudinal axis of said jib, and a pneumatically operated piston is provided for applying pressure to displace said bolt in said tube.

7. A crane jib as claimed in claim 2, further comprising at least one lifting drum for a hoist mechanism of said crane jib, said at least one lifting drum being mounted on said supporting carrier.

8. A crane jib as claimed in claim 7, further comprising a drive mechanism for said at least one lifting drum, said drive mechanism also being mounted on said supporting carrier.

9. A crane jib as claimed in claim 1, wherein said jib housing comprises an upper portion separate from said lower portion and mounted for telescopic extension and retraction relative to said lower portion, means on said upper portion for connecting said upper portion through said telescopic jib parts to said extending and

retracting cylinder whereby said cylinder is used to extend and retract said upper portion of said housing.

10. A crane jib as claimed in claim 1, wherein said means for locking each adjacent pair of said telescopic parts end to end comprises a guide tube mounted at the lower end of the upper of said pair of telescopic parts, a locking bolt mounted for displacement in said guide tube, a double acting fluid pressure operated cylinder for displacing said locking bolt in said guide tube, means defining a locking bore in the upper end of the lower of said pair of telescopic parts for receiving said locking bolt when said bolt is displaced from said guide tube, and cooperating means on said telescopic parts for determining alignment of said locking bolt with said locking bore.

11. A crane jib as claimed in claim 1, further comprising a catch mechanism disposed at the upper end of said tube housing, said catch mechanism including a guide tube mounted on said housing, a catching bolt mounted in said guide tube for displacement therein, and a double acting fluid pressure operated cylinder for displacing said catching bolt in said guide tube, means defining a catching bore at the upper end of each of said telescopic parts for receiving said catching bolt, and cooperating means on said catch mechanism and said telescopic parts which engage each other when said catching bolt is aligned with one of said catching bores.

12. A crane jib as claimed in claim 11, wherein said guide tube, and hence said catch mechanism, is mounted for displacement through a limited distance in the vertical direction, and there is provided means for controlling operation of said cylinder for displacing said catching bolt in dependence upon the vertical position of said catch mechanism relative to said housing.

13. A crane jib as claimed in claim 10, wherein said locking means includes a sleeve surrounding said locking bolt and axially slidably mounted in said guide tube, said sleeve forming part of said cooperating means for determining alignment of said bolt with said locking bore.

14. A crane jib as claimed in claim 13, wherein said locking bolt has a reduced diameter shank portion at its end adjacent its operating cylinder, and an end plate is mounted in said sleeve surrounding said locking bolt and is provided with means defining a bore through which said shank portion extends, said end plate serving as a stop surface for said locking bolt.

15. A crane jib as claimed in claim 14, including a compression spring disposed for action between said end plate and said operating cylinder whereby said sleeve is urged by said spring away from said cylinder.

16. A crane jib as claimed in claim 14, wherein said sleeve has a nose at its end remote from said end plate, and said lower of said pair of telescopic parts is provided with a member which engages with said nose when said pair of parts are locked end to end to prevent removal of said locking bolt from said locking bore.

17. A crane jib as claimed in claim 16, wherein said lower of said pair of telescopic parts has a stop plate displaced from said member for engaging with said nose, said stop plate being displaced from said member by substantially the length of said nose and said stop plate including said means defining said locking bore.

18. A crane jib as claimed in claim 17, including a reinforcing plate mounted on said stop plate and having means defining a bore in registry with said locking bore.

19. A crane jib as claimed in claim 10, wherein the lower of said pair of telescopic parts is provided with a stop at its upper end for engagement by said guide tube on the other of said pair of telescopic parts to prevent said parts from becoming disconnected.

20. A crane jib as claimed in claim 19, wherein said stop and said guide tube form said cooperating means for determining alignment of said locking bolt and said locking bore.

21. A crane jib as claimed in claim 19, wherein said stop is provided with a slot, a double armed rocker is pivotally mounted above said guide tube, and a sensor for controlling operation of said cylinder for moving said locking bolt is mounted for operation by said rocker, whereby when said pair of telescopic parts are moved into position for being locked together one arm of said rocker is received in said slot in said stop and is caused to pivot to bring the other arm of said rocker into engagement with said sensor to cause movement of said locking bolt.

22. A crane jib as claimed in claim 10, wherein said locking bolt is provided with a retaining groove at its free end.

23. A crane jib as claimed in claim 10, wherein said cooperating means for determining alignment of said locking bolt with said locking bore comprises mating concave and convex surfaces respectively on the lower and upper of said pair of telescopic parts.

24. A crane jib as claimed in claim 12, including a sleeve surrounding said catching bolt and axially slidably mounted in said guide tube, said sleeve forming part of said cooperating means for determining alignment of said catching bolt with a catching bore.

25. A crane jib as claimed in claim 24, including compression spring disposed vertically for action between said housing and said catch mechanism, said vertical compression spring supporting said catch mechanism without external loading in a rest position which is substantially mid way between the upper and lower

limits of displacement of said mechanism.

26. A crane jib as claimed in claim 25, including a compression spring disposed horizontally for action on said sleeve surrounding said catching bolt to urge said sleeve into a position for engagement by the upper end of a telescopic part, said sleeve being urged into this position when said catch mechanism is in its rest position.

27. A crane jib as claimed in claim 26, including a tube fixidly mounted to said housing, a stop carried by said tube, a further sleeve slidably mounted around said tube and welded to said guide tube whereby the axis of said further sleeve is perpendicular to the axis of said guide tube, and a cover fixed to said further sleeve at its end adjacent said guide tube, said vertically mounted spring acting between said stop and said cover.

28. A crane jib as claimed in claim 27, including an entrainment bolt mounted for movement with said further sleeve, and means provided on said entrainment bolt for actuating said means for controlling the operation of said cylinder for moving said catching bolt.

29. A crane jib as claimed in claim 28, wherein said catching bolt and said sleeve surrounding said bolt are retracted from a position of engagement with a telescopic part when said catching mechanism is at its upper limit of displacement.

30. A crane jib as claimed in claim 29, wherein said catching bolt and said sleeve surrounding said catching bolt are in a projecting position for engaging a telescopic part when said catching mechanism is at its lower limit of displacement.

31. A crane jib as claimed in claim 10, further comprising a push rod on said telescopic part carrying said locking bolt, a sensor for initiating retraction of said locking bolt and disposed for actuation by said push rod, a spring urging said push rod away from said sensor, and a mechanism mounted on said jib housing for displacing said push rod against the action of said spring to actuate said sensor when said telescopic part is correctly positioned relative to said housing and said telescopic parts are to be retracted.

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