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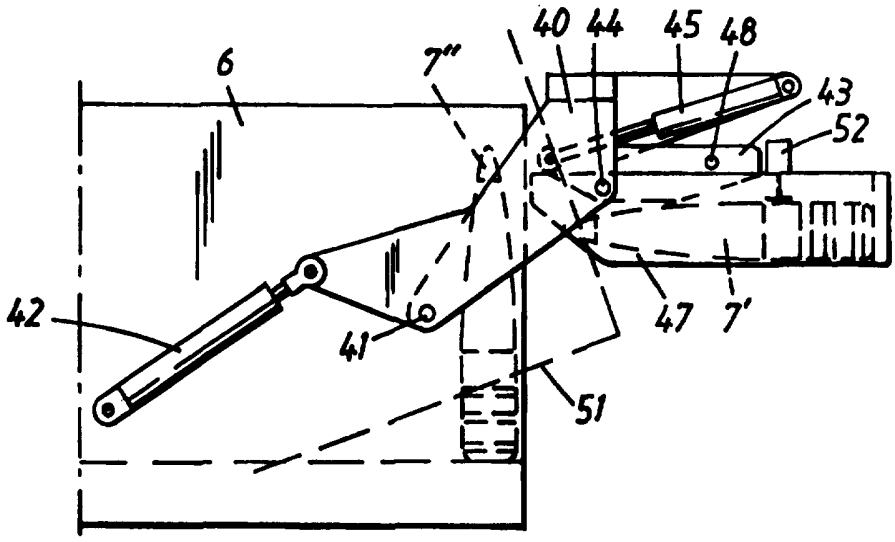
(57) Abstract

The present invention relates to a method and a device which are used, in automatically loaded artillery guns (1 - 5) provided with carriage-mounted shell and/or propellant magazine (6), for transferring ammunition components such as principally shells (7), but also, in an appropriately modified form, propellant charges (20), from a freely selectable compartment in the said magazine (6) to a flick rammer (12, 38, 50) which is incorporated in the elevation system of the gun or which is connected to the said elevation system in terms of movement, the transfer of the ammunition components (7) in question being effected both between different planes and between different angle positions.



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Case 3536

# AMMUNITION FEEDER

The present invention relates to a method and a device which are used, in automatically loaded artillery guns provided with carriage-mounted shell and/or propellant magazine, for transferring principally shells, but also, in an appropriately modified form, propellant charges, from a freely selectable compartment in the said magazine to a rammer which is incorporated in the elevation system of the gun or which is connected to the said elevation system in terms of movement.

Modern artillery tactics presuppose extremely high loading speeds, even for heavier guns, and at the same time entail the need for rapid changes in the gun elevation and in the size of the propellant charges between the different shots in a salvo. This is of course done in an attempt to get as many shells as possible to hit the target area as close upon each other as possible, and this is achieved by firing the various shells in one and the same salvo towards the target area along trajectories of different heights. In addition, the increased maximum firing ranges of the guns mean that there is an ever greater number of different propellant charges to alternate between. The most flexible type of propellant charge available at present consists of a variable number of charge modules with combustible and essentially stiff outer casings. These charge modules are found in at least two basic types, of which one type is designed so that the various modules can be connected to larger or smaller charges, but not even these connected charge modules have the same stability as a unit charge of an older type, and charges made up of such charge

modules are therefore more difficult to ram automatically than the completely stiff unit charges with metal, plastic or combustible casings. In the alternative case where the charge modules in accordance with the above are not even connected to each other, the difficulties of course increase to a corresponding extent.

A major problem for today's gun constructors has therefore been to develop a novel loading system which is sufficiently fast to satisfy modern artillery techniques and which at the same time is of sufficient flexibility that it is entirely possible to use the abovementioned module charges and in so doing to benefit from all the advantages thereof. Another problem has then been to develop an effective system for automatic loading of the gun in question with a freely selectable shell taken from a magazine which is preferably carriage-mounted, i.e. from a magazine which is at all times accessible on the gun but which, because it does not follow the elevation of the gun, means that when the shells are being fed for ramming, it is necessary to bridge a plurality of angle positions and movements in different planes. Trials with gun-mounted shell magazines which follow the gun elevation have shown that although the automatic loading system is then considerably simpler, the magazine capacity at the same time has to be limited, for weight reasons, to far too great an extent, and at the same time it becomes difficult to fit the magazine with new shells and propellant charges.

What is expected to be a main component in the general loading system of the future has already been available for some years now, namely the so-called flick rammer with which it is also possible to effect a rapid ramming of larger shells at high elevations. As the name suggests, the flick rammer is designed to throw shells and/or propellant charges at high speed into the ramming device in the gun in question. However, the flick rammer is chiefly used today for shells and completely stiff unit charges, for example of the type with combustible casings or discardable casings made of plastic or metal.

On the other hand, it has hitherto been difficult to get the flick rammer to function satisfactorily with module charges of the abovementioned types. It is also true that flick rammers, if they are to function without error, depend on extremely precise alignment in relation to the gun barrel. However, the artillery systems of the future will probably not be equipped only with flick rammers, but also with other rammers.

The present invention now relates to a method and a device for the handling of ammunition components, such as shells and propellant charges, until they are ready for ramming in the loading trough of a rammer. The invention also includes the design of the carriage-mounted shell magazine which, by virtue of the said design, allows for the use of a large number of shells which can in addition be of several different types and which can be selected freely with regard to the type of target in the particular case in question.

The premises which obtain in respect of the method and the device according to the invention are therefore, in the first instance, that the magazine shall be able to contain a large number of shells, which means that the said magazine, if it is to be a fixed part of the gun, must be mounted on the carriage, and, in the second instance, that the magazine shall contain several different types of shells which shall all be available for use at all times, and, in the third instance, that the ramming of the shells in the gun barrel shall be effected with a rammer which is incorporated in the elevation system of the gun, since this is the surest way to guarantee at all times a correct alignment between rammer and gun barrel, which alignment is an absolute requirement if the ramming is to be correct and is to function without error even at high elevations.

These premises in turn mean that when the ammunition components are being moved from the magazine to the rammer, several different angle positions have to be bridged and the shells and propellant charges have to be moved in several different planes and directions.

According to one variant of the invention, as far as the shell magazine is concerned, the problem of permanent access to shells of different types has been solved by means of the magazine being designed with the same number of longitudinal feed paths as there are different types of shell, and the shells are fed along these paths step by step, standing on their rear end. The shells are thus advanced in a controlled manner so that provided the respective feed path has not been completely emptied, there will always be a shell of each sort available in the delivery opening of the magazine.

The basic principle of the method and the device according to the invention is in other respects that a first or outer cradle, which is journalled about a straight line which passes through the gun trunnion centre, shall be responsible for feeding a shell or the like, which is suspended in a loading pendulum, from an essentially horizontal zero position to an angle position which corresponds to the elevation of the gun. An inner cradle is pivotably mounted in this outer cradle, and the loading pendulum is suspended in the said inner cradle. The inner cradle, which can constitute a part of the loading pendulum, is responsible for the latter's movement from a position immediately outside the delivery opening of the magazine to the said zero position. For transferring a shell, for example, to the loading pendulum, the feed function of the magazine is quite simply used, which function, when it is activated, pushes a new shell forwards to the outlet of the delivery opening, and the shell which was previously standing in this position is quite simply pushed over into the loading pendulum. In the variant in which the magazine has several feed paths, the loading pendulum is in turn made such that it can be displaced sideways in the inner cradle, or together with the latter, as a result of which it is possible to set the loading pendulum in front of the shell which has been selected for use. This sideways displacement function can also be used so that the loading pendulum, in the final stage of its movement,

will reach a laterally offset flick rammer to which it will transfer the shell by positioning itself directly over the same and opening the locking function and, at least at high elevations or when the feeder is used for propellant charges, activating an ejector which actively displaces the object in question from the loading pendulum and over to the rammer in question.

The invention has been defined in the patent claims which follow and it will now be described in somewhat greater detail with reference to the attached figures, in which:

Figure 1 shows an oblique projection, in partial cross-section, of an artillery gun designed in accordance with the invention, but with the undercarriage having been omitted for the sake of clarity,

Figure 2 shows, on a larger scale, an oblique projection, in partial cross-section, of the magazine from which the gun is supplied with propellant charges,

Figure 3 shows, on a different scale, an oblique projection, in partial cross-section, of the shell magazine,

Figures 4 - 6 show diagrammatically, on a larger scale, how the shells are moved in every respect other than their sideways displacement, and

Figures 7 and 8 finally show details of some important parts in Figures 4 - 6, which parts are designed slightly differently than corresponding parts in Figures 1 - 3, even though the function is the same.

The artillery gun shown in Figure 1 includes the barrel 1 with recoil buffers and recuperator 2, muzzle brake 3, gun cradle 4 and a conventional screw mechanism 5 which is shown in the open position in the figure. The figure also shows some of the components which are important for the functioning of the finished gun, such as the shell magazine 6 which, in the example shown in the figure, holds shells 7 of three different types which are arranged in three different rows and which can be fed out individually. The number of rows of shells can be varied within the limits which apply in respect of the

maximum allowable width of the complete gun. There is a pivotable cradle 8 arranged on the shell magazine 6. In the cradle 8, a shell pendulum 9 is suspended pivotably and displaceably on the axle 9a. The shell pendulum 9 can be pivoted in from the position shown in the figure, where it lies essentially horizontally, to a vertical position immediately adjacent to the delivery end 10 of the magazine 6. By means of the inherent sideways displacement function, which can be based, for example, on the axle 9a which supports the shell pendulum 9 being in the form of a threaded rod which is driven by a motor adapted thereto, while the bearing of the shell pendulum 9 for this rod is a freely rotating nut 9b, or vice versa, it can additionally be placed directly in front of the shell with which the gun is to be loaded. With the aid of the grabs 11 which form part of the shell pendulum 9 and which are indicated in the figure, the pendulum takes hold of the shell in question when the latter has been pushed over, by an ejector function built into the magazine, onto the base plate 9c of the pendulum, after which the pendulum is transferred, by a hydraulic piston or other adjusting means 9d fitted between the pendulum and an axle 8a, to the horizontal position shown in Figure 1. The shell pendulum is thereafter moved sideways to a position in line with and above the rammer 12, whereupon the shell pendulum cradle 8 (which is journalled in the gun trunnion centre) swings with the shell pendulum to a position which corresponds to the gun elevation, after which the shell can be transferred directly to the rammer 12, which also follows the gun elevation, and from which the shell is thereafter rammed once the rammer has been brought fully into alignment with the barrel 1.

The propellant magazine 13 of the gun is also shown in Figure 1, but it is shown mainly in Figure 2. A mechanically displaceable endless chain conveyor runs in the propellant magazine 13, the said chain conveyor consisting of several vertical sets of compartments 14 which are hinged together to form a chain. In the

figures, these are shown as chutes open on one side. Each one of these sets of compartments or chutes 14 includes a number of compartments 15 - 19 each initially holding one propellant module, or in the case of the compartment 15 two propellant modules, generally designated by 20 hereinafter. The number of propellant modules in each compartment can of course be varied between one and several, depending entirely on which gun is being considered and on the size of the propellant modules. The sets of compartments 14 are intended to be fed successively by the endless chain conveyor to a vertical delivery opening 21 formed in the magazine 13. In this position, all the propellant modules 20 present in the various compartments of the set of compartments can be acted on by the ejectors 22 - 26 designed for this purpose. The ejector 22 is completely hidden in Figure 2, while the ejector 26 is largely hidden. The intention is in fact that the delivery opening 21 will be supplied, as and when necessary, with new sets of compartments which have all their compartments 15 - 19 filled with propellant modules, and, of these propellant modules, a number adapted for each firing will be displaced by the ejectors 22 - 26 over to a loading pendulum 27 lowered alongside the delivery opening, which loading pendulum 27 has, on the one hand, a first inherent lowering function 39 which is used for lowering the loading pendulum alongside the delivery opening 21, and, on the other hand, a second lowering function in the form of the cradle 28 which is journalled in the gun trunnion centre and in which it is secured and with which it can be lowered to an angle which is adapted to the gun elevation in order to lie, in the same manner as for the shell, in an angle position adapted to its own propellant charge rammer 38 for direct transfer of the propellant charge to the propellant charge rammer 38 which depends for its angle position on the gun elevation. The loading pendulum is also arranged in the cradle 28 such that it can be displaced sideways along a guide beam 29. This means that its transverse position can also be aligned in relation

to the propellant charge rammer 38. The guide beam 29 can, as in the case of the shell pendulum, be a threaded axle which is rotated by means of a suitable drive member and which both supports the loading pendulum and displaces it sideways. When the required number of propellant modules 20 have been transferred to the loading pendulum 27, the endless chain conveyor made up of the sets of compartments 14 is moved by driven cog wheels 30 being turned one step, and the propellant modules 20 which were not made use of in the previous set of compartments return to the system, while at the same time a full complement of propellant modules corresponding to the maximum loading of the gun are thereafter available once again at the delivery opening 21 for the next loading operation.

The transfer of the predetermined number of propellant modules 20 to the loading pendulum 27, by means of these being ejected from their respective compartments 15 - 19 by the ejectors 22 - 26, is carried out with the loading pendulum 27 in the lowered vertical position alongside the delivery opening 21.

The loading pendulum is built around a main beam 31 which has a journal 32 for the guide beam 29 along which the loading pendulum can also therefore move sideways. It also has two long side walls 33, 34 which are adapted to the external form of the propellant modules 20 and which are hinge-journalled and can be opened by means of a common hydraulic piston 35 (see Figure 1), and a fixed counter-support 36 which is arranged at the end of the loading pendulum and which points downwards when the latter is lowered against the delivery opening 21 of the magazine. Inside the loading pendulum there is additionally a compacting heel 37 which is partly hidden in the figures and which is movable in its longitudinal direction from the end opposite the said fixed counter-support 36 towards the latter.

The loading pendulum 27 now functions such that when it is first lowered vertically against the delivery opening 21 and its long sides 33, 34 are opened to a

sufficient extent to allow the propellant modules to be supplied to the same, the desired number of propellant modules 20 are transferred to the loading pendulum 27. As soon as this operation has been carried out, the hydraulic piston 35 is activated and the long sides 33, 34 of the loading pendulum are closed, and during the final stage of this closing operation the various propellant modules are forced to form a straight column one directly above the other. The hydraulic piston is thereafter activated and manoeuvres the compacting heel 37 so that the latter is displaced against and presses the various propellant modules 20 together. The loading pendulum is then raised and is displaced sideways so that it lies in line with and above a rammer, shown in Figure 1, in the form of a flick rammer 38, whereupon the loading pendulum cradle 28 (which is journalled in the gun trunnion centre) swings together with the loading pendulum to a position which corresponds to the gun elevation, and with the loading pendulum immediately above the flick rammer. The propellant charge is then added to the flick rammer by means of the long sides of the loading pendulum being opened, after which the propellant charge is pressed into the flick rammer by a member which is adapted for this purpose and which can be a hydraulic piston, or an electrical adjusting member, or a spring pretensioned at an earlier stage of the loading sequence, or another mechanical device.

The detailed construction of the two rammers 12 and 38 has nothing to do with the present invention, and for this reason they are not described in any detail. It will suffice to note that in their rest and filling position, which is shown in Figure 1, they lie alongside the gun recoil, and that upon ramming they are moved sideways, one after the other, into line with the barrel, whereupon the shell and propellant charge are rammed. By virtue of the fact that the rammers are journalled in a frame which forms part of the gun elevating system, only a lateral alignment of the rammers is required for the complete alignment to be correct.

The movement sequence illustrated in Figures 4 - 6 involves the use of a somewhat different device from the one which is shown in Figures 1 and 3. The main parts of the device are shown in Figures 7 and 8. These include a first or outer cradle 40 which is journalled at the gun centre trunnion at journal point 41. The movement scheme of this outer cradle is identical to that which applies to the cradle 8. For swinging the cradle between its different positions, there is a hydraulic piston 42 which can be the same piston as in Figures 1 and 3. An inner cradle 43 is pivotably mounted in this outer cradle about an axle 44 which is parallel to the journal points 41. The swinging movements of this inner cradle are controlled by a hydraulic piston or another suitable member 45 tensioned between a cam 46 on the inner cradle and the outer cradle. A shell pendulum 47 is also suspended in a laterally displaceable manner in the inner cradle. Except for its slightly different suspension, the loading pendulum 47 is identical in conception to the shell pendulum 9. The sideways displacement of the loading pendulum 47 is controlled, as in the case of the loading pendulum 9, by a threaded rod 48, which is driven by a hydraulic motor, electric motor or other member (not shown), and a free-running nut 49 at the connection point to the pendulum.

The whole shell-collecting sequence is now shown in Figures 4 - 6. Figure 4 shows the starting position in which the hydraulic piston 45 lowers the shell pendulum 47 in front of the delivery opening of the magazine 6 and a shell 7' has been pushed over into the pendulum, while the next shell 7'' has taken up the next delivery position.

All these figures also show the rear contours 51 of the artillery gun 1 - 5 elevated to 70°. Once the locking members (not shown in the figures) have been activated, the inner cradle is transferred with the shell pendulum and the shell by the hydraulic piston or equivalent 45 to the zero position shown in Figure 5. At that point, or already during the movement on the way to

that point, the hydraulic piston 42 is activated and the outer cradle 40 is lowered, with its contents in the form of the inner cradle 43 and the shell pendulum 47, to the position shown in Figure 6, in which position the shell 7' lies immediately above an indicated rammer 50 to which the shell is pressed over by the member 52 as soon as the locking members of the pendulum are opened. If necessary, this function sequence has also involved a sideways displacement in the manner previously indicated.

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PATENT CLAIMS

1. Method for transferring, in automatically loaded artillery guns, a vertically standing ammunition component, such as a shell (7) or a propellant charge (20), which is available in a delivery opening (10) of a carriage-mounted magazine (6) belonging to the gun, from the magazine (6) to a flick rammer (12) which is incorporated in the elevation system of the gun, characterized in that the ammunition component (7), by being ejected from the magazine (6) without any change to its vertical main direction, is transferred to a loading pendulum (9, 47) which has been swung down immediately outside the delivery opening of the magazine and in which the aforementioned component (7) is locked, as soon as it has taken up its position, by means of a member (11) adapted for this purpose, after which the loading pendulum (9, 47), by means of a first swing movement about a first rotation axle (9a, 44), is raised until the ammunition component lies in an at least essentially horizontal zero position, after which the loading pendulum (9, 47), by means of a second swing movement of an outer cradle (8, 40), in which the first rotation axle is journalled, and which itself is journalled about an axle (41) which coincides with the line through the gun trunnion centre, is swung down with the ammunition component (7) to an angle which coincides with the elevation of the gun (1 - 5) and to a position immediately above the rammer (12) to which the ammunition component (7) can be transferred, by a member (52) adapted to this purpose, as soon as the locking member (11) of the loading pendulum has been opened.

2. Method according to Claim 1, characterized in that as the shell magazine (6) is so designed that there are several different shells (7) arranged alongside each other at its delivery opening, the movement of the shell pendulum is supplemented by a sideways displacement

function (9a, 9b, 48) so that it can be displaced directly in front of the shell which has been selected for use.

3. Device for transferring, in automatically loaded artillery guns (1 - 3) in accordance with the method according to either Claim 1 or 2, a vertically standing ammunition component, such as a shell (7) or a propellant charge (20), which is available in a delivery opening (10) of a carriage-mounted magazine (6) belonging to the gun (1 - 5), from the magazine to a flick rammer (12) which is incorporated in the elevation system of the gun, characterized in that it comprises a first outer cradle (8, 40) which can be swung relative to the magazine and whose journal axle (41) coincides with a line through the trunnion centre of the gun (1 - 5), and a loading pendulum (9, 47) which is mounted so that it can pivot in the outer cradle (8, 40) about an axle (44, 9a) parallel to the axle (41) of the latter and which extends across these axles and includes a base support plate (9c) against which a shell (7) can be supported, and a member (11) for securing an ammunition component which is placed on the base plate (9c) and aligned with the loading pendulum, and where the first outer cradle (8, 40) can be swung from a first more or less horizontal zero position to a second angle position which in each case coincides with the gun elevation, while the loading pendulum (9, 47) can be swung from a first vertical position, where it is situated immediately outside the delivery opening (10) of the magazine and parallel with respect to the ammunition component (7) situated therein, to a second position parallel with respect to the zero position of the outer cradle (8, 40), and where the magazine (6) is provided with members for pushing the ammunition component in the delivery opening (10) over into the loading pendulum (9, 47), whereupon its locking function (11) is closed, after which the loading pendulum (9, 47) and the outer cradle (8, 40) can be swung to their respective second positions, this placing the ammunition component (7) immediately above the rammer (12), in which

position the locking member of the loading pendulum can be deactivated and a member (52), forming part of the loading pendulum, for displacing the ammunition component out of the pendulum (9, 47) is activated.

4. Device according to Claim 3, characterized in that the magazine (6) is designed with several different ammunition components such as shells (7) simultaneously available alongside each other at the delivery opening (10), at the same time as the inner cradle comprises members (9a, 9b, 48, 49) for parallel sideways displacement of the loading pendulum (9, 47) so that it can be placed in front of the shell which has been selected.

5. Device according to Claim 4, characterized in that the carriage-mounted magazine (6) has several feed paths which run in parallel alongside each other and along which a corresponding number of different ammunition component types are arranged to be fed step by step as and when an ammunition component (7) standing at the front in the delivery opening of the respective feed path has been removed.

6. Device according to Claim 5, characterized in that the step by step advance of the ammunition components (7) is also designed in such a way that it can be used for ejecting the desired component from the magazine (6) and over into the loading pendulum (9, 47).

Fig. 1

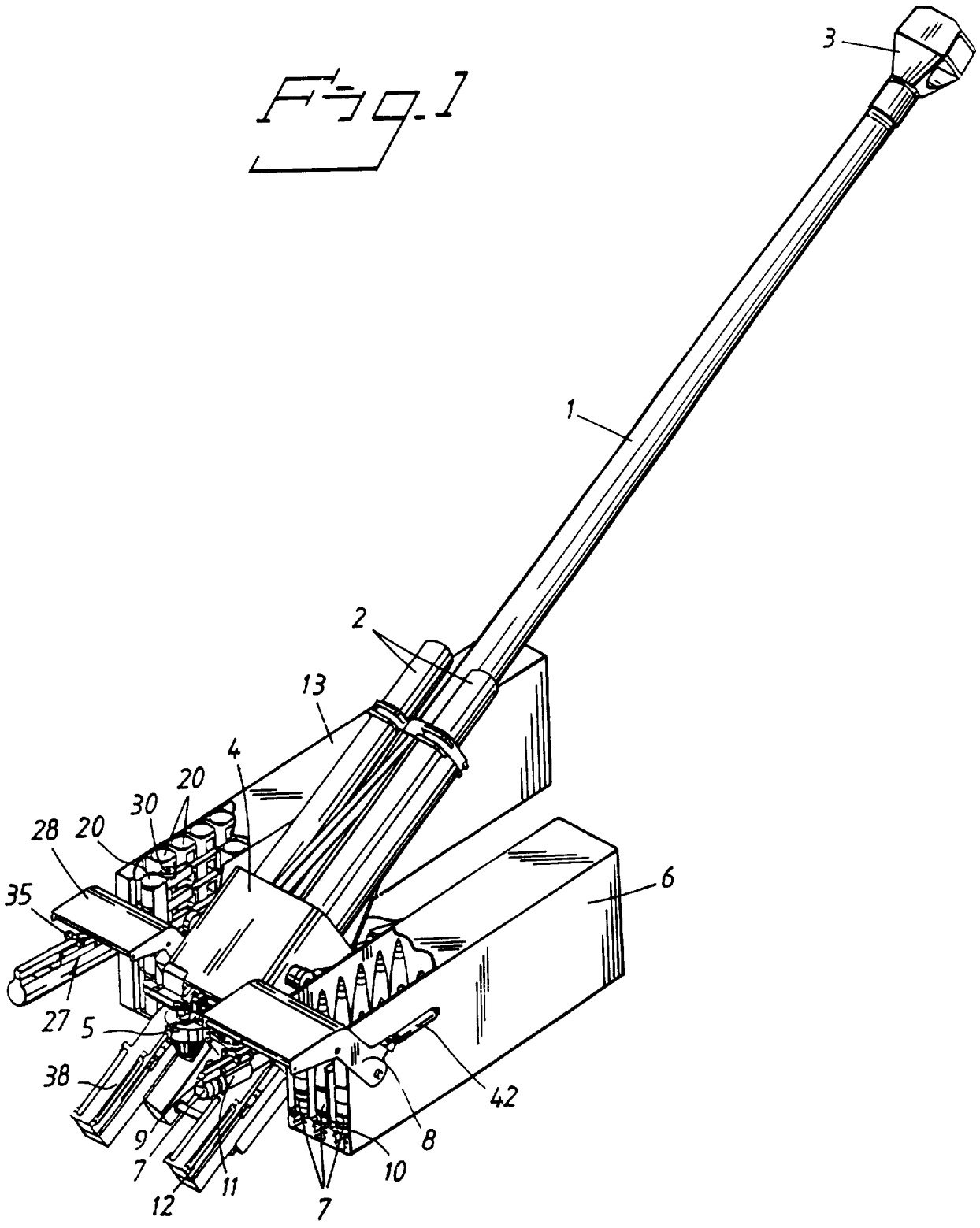

Fig. 2

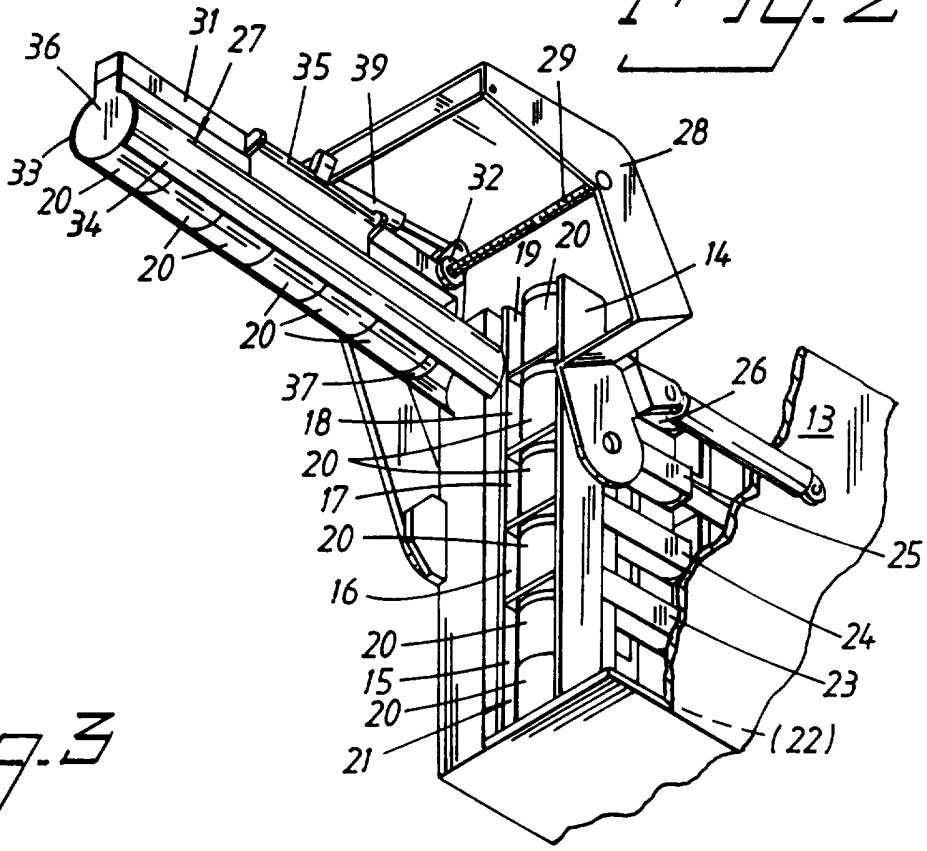
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Fig. 3

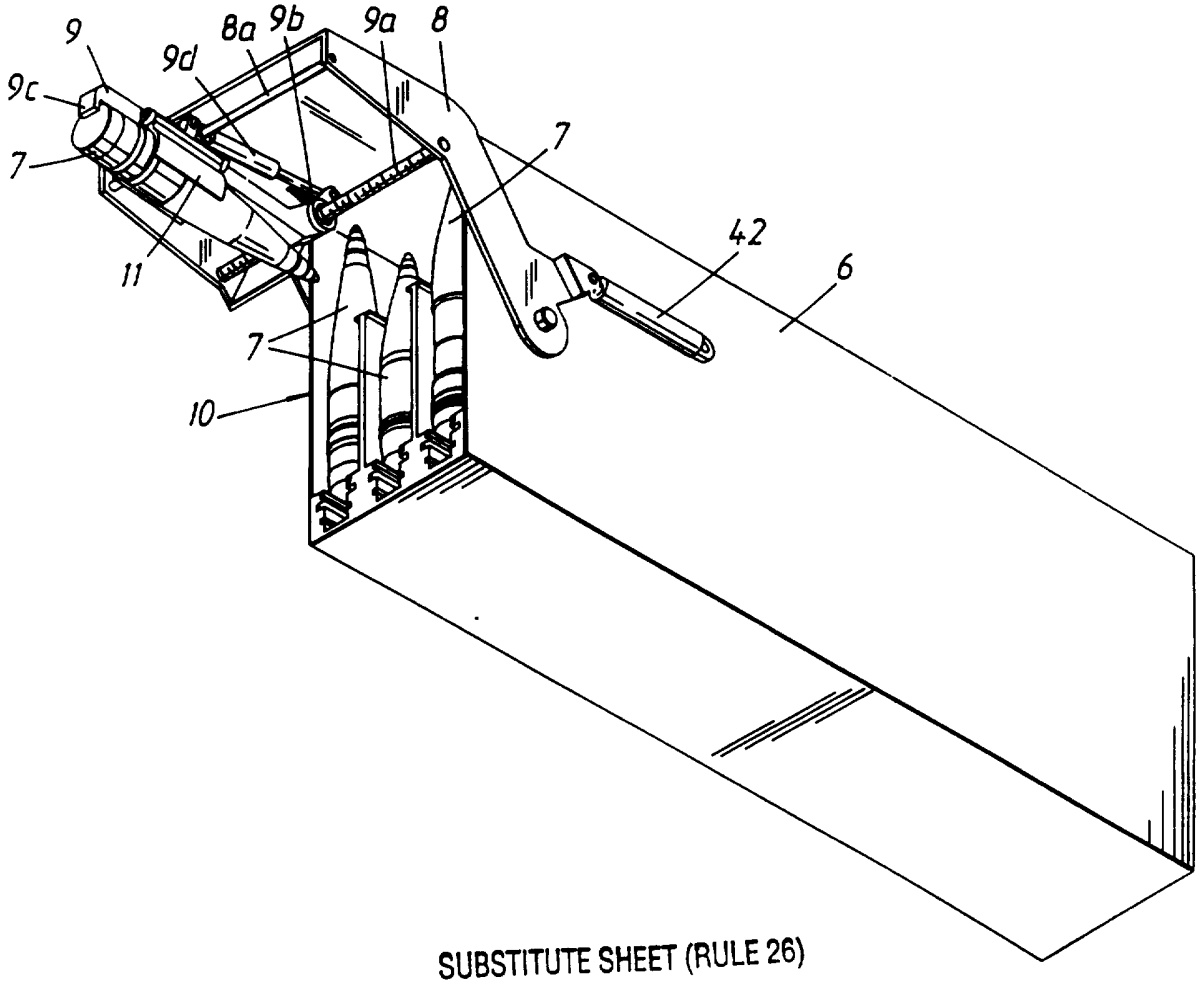
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Fig. 4

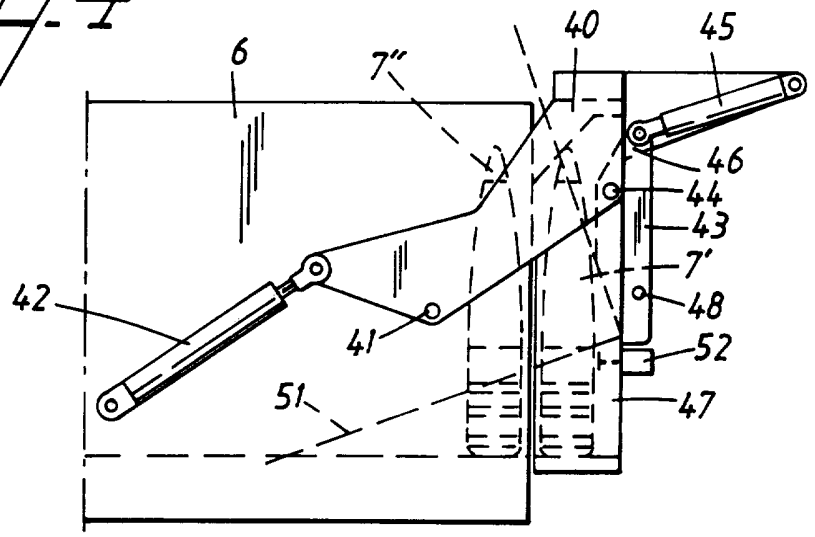
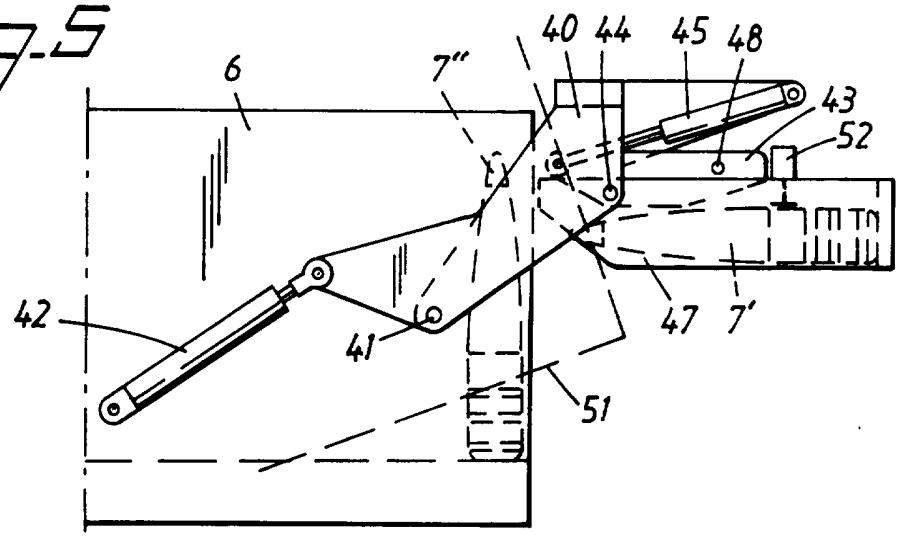



Fig. 5



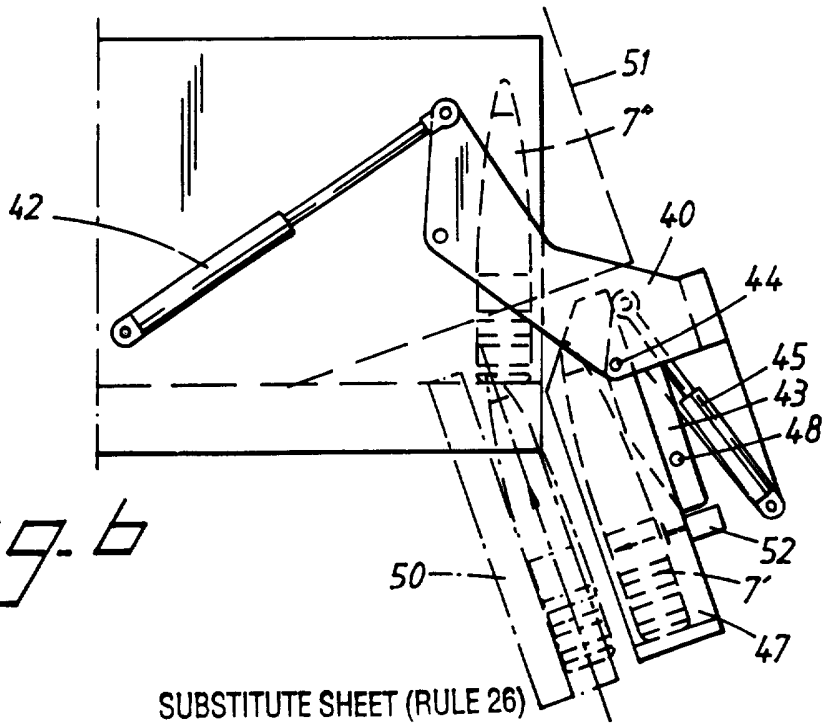




Fig. 6

Fig. 7

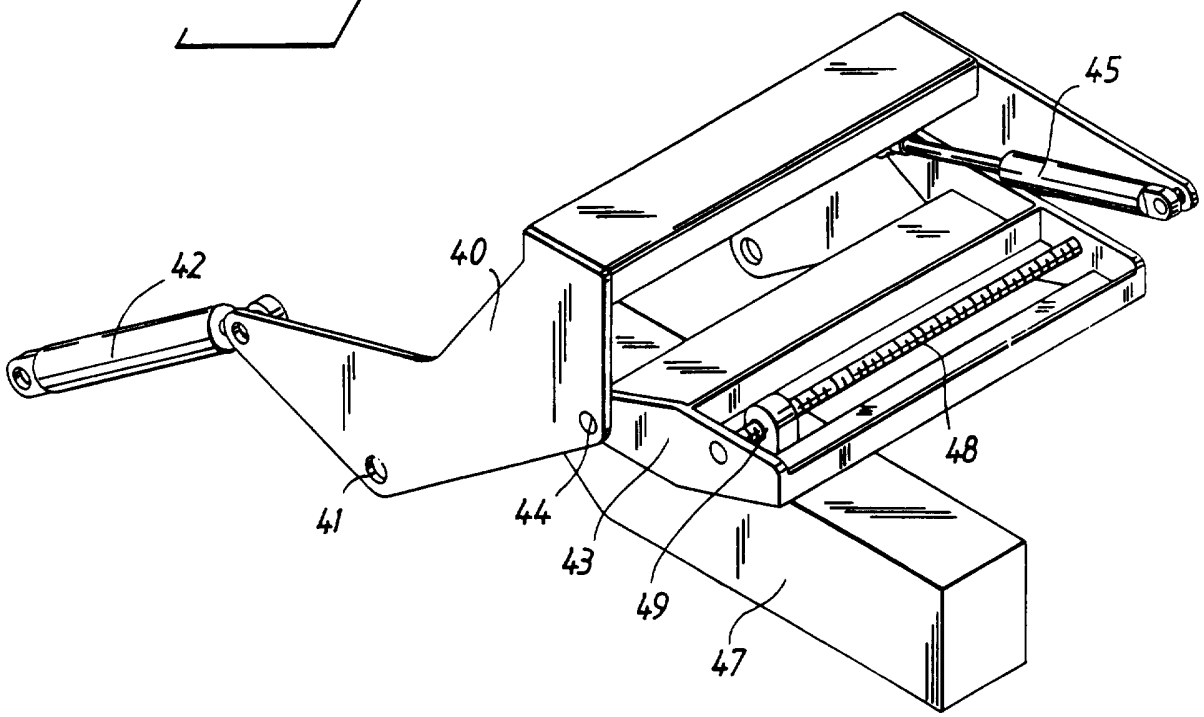
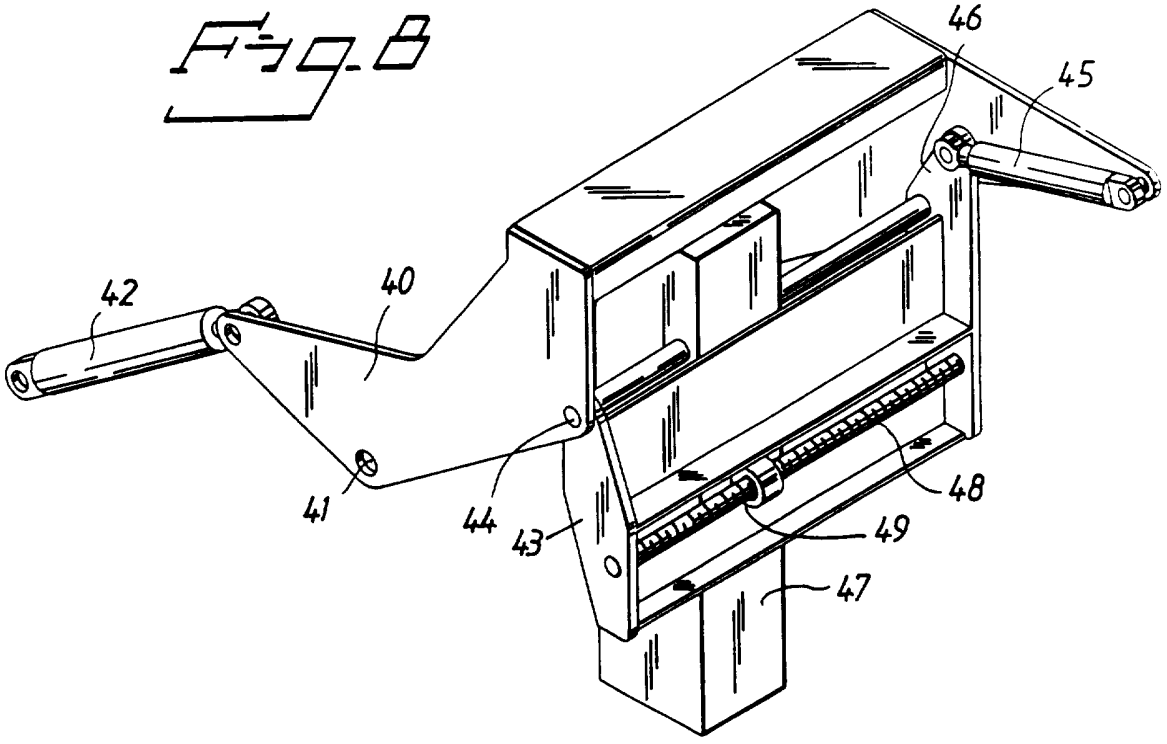



Fig. 8



# INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 95/01181

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F41A 9/01, F41A 9/16
According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F41A

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 4481862 A (R.H. WIETHOFF ET AL), 13 November 1984 (13.11.84), figures 1-3,24A-24H<br><br>--<br>-------- | 1,3 |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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|---|---|
| 12 January 1996 | 02.02.96 |
| Name and mailing address of the ISA/<br>Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86 | Authorized officer<br><br>Jonas Löfgren<br>Telephone No. +46 8 782 25 00 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

11/12/95

International application No.
PCT/SE 95/01181

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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| US-A- 4481862 | 13/11/84 | EP-A,A,A 0105101 | 11/04/84 |