July 14, 1970 G. S. NEINAST 3,520,573

EXCAVATOR APPARATUS

Filed July 5, 1968

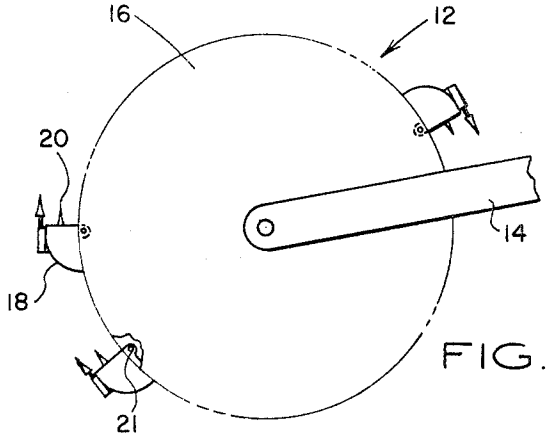


FIG. 1

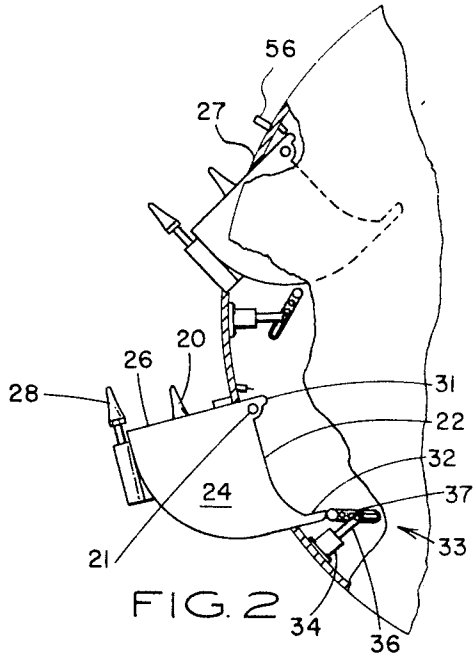


FIG. 2

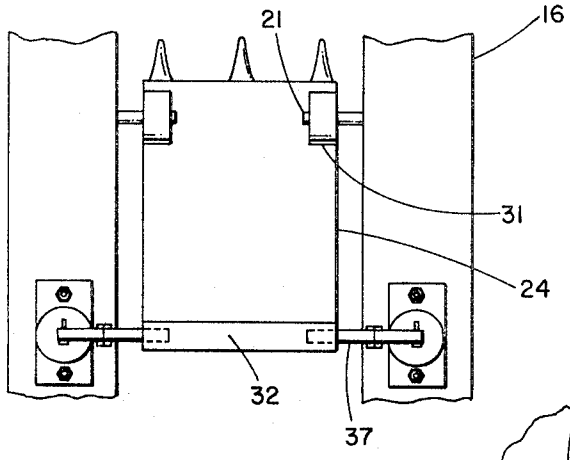


FIG. 4

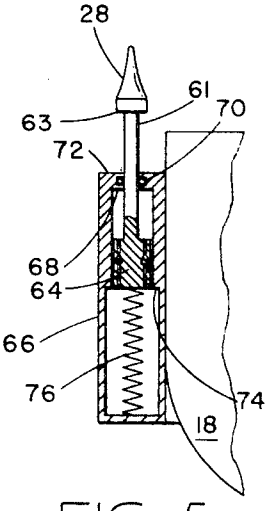


FIG. 5

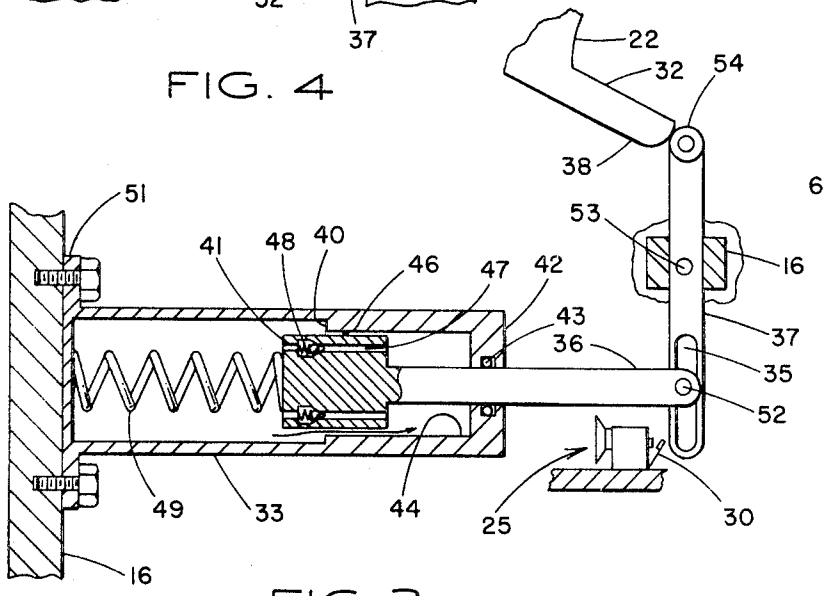


FIG. 3

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United States Patent Office 3,520,573 Patented July 14, 1970

3,520,573

EXCAVATOR APPARATUS

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Filed July 5, 1968, Ser. No. 742,598
Int. Cl. E21c 35/02, 3/00
U.S. Cl. 299—1 11 Claims

ABSTRACT OF THE DISCLOSURE

The particular embodiments described herein as illustrative of one form of the invention utilize an apparatus for releasing an excavator bucket in the event the bucket encounters an unusually hard material within the material being excavated, so that the bucket can pivot out of contact with the material. Provisions are also made for utilizing a mechanism on the bucket to impart a jarring impact to such unusually hard materials.

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for excavating earth materials and more particularly, to an apparatus for excavating hard materials from earth formations.

A problem associated with the excavating or mining of earth materials is the wear and breakage of earth contacting portions of excavating equipment, which, for example, may be in the form of bucket teeth. Wear is normally the result of abrasion and impact with earth materials being excavated. An example of this problem involves the mining of bituminous tar sands. The sands are composed of a siliceous material, generally having a size greater than that passing a 325 mesh screen, saturated with a relatively heavy, viscous bitumen in quantities of from 5 to 21 weight percent of the total composition. The bitumen is quite viscous and contains typically 4.5% sulfur, and 38% aromatics. A specific gravity at 60° Fahrenheit, ranges typically from about 1 to about 1.06. The tar sands also contain clay and silt in quantities from 1 to 50 weight percent of the total composition. Silt is normally defined as mineral which passes a 325 mesh screen, but which is larger than 2 microns. Clay is mineral smaller than 2 microns, including some silicious material of that size. The composition described, together with the peculiar consistency due to its viscous nature, has been found to exhibit extreme wear properties on equipment normally used for excavating earth materials. Therefore it is desirable, in the design of such equipment, to use materials which exhibit good wear properties in such an environment. However, layers of hard rock material are often encountered in the formations containing the tar sands. Also, boulders or large rock masses are found embedded in the tar sands. Due to the encountering of such hard materials, it is costly to use some materials in the construction of excavating equipment which might otherwise be applicable, because of their wear properties. For example, tungsten carbide bucket teeth exhibit desirable wear properties for excavating the abrasive tar sand material, but are not compatible with the excavation of hard rock, because of the brittle nature of tungsten carbide.

The present invention is therefore directed to an apparatus for mining earth materials and in particular, tar sands under the conditions described above. In its most specific embodiment, the invention is disclosed with a bucket wheel excavator for mining the tar sands. However, the apparatus disclosed would have application to a variety of excavating techniques employed with a variety of earth materials. Regardless of the particular excavating apparatus utilized for mining earth materials,

continuous contact between an excavating member and earth materials causes a great deal of wear on the members. It is proposed by the present invention to use materials in the construction of the bucket teeth which will reduce this wear, and to provide means for preventing the teeth from breaking upon contact with unusually hard substances. In addition, means are provided for breaking up hard layers of materials encountered within the particular material being excavated.

In mining tar sands, as with other materials, the excavator is often mounted on a wheel, with the wheel being rotated to force the bucket teeth or blades into the earth material, such as tar sand deposits, to carry the sands upwardly, and to discharge the sands by gravity adjacent the top point of the bucket rotation. Continuous contact between the bucket teeth or blades and the deposit wears the teeth to a point where they are no longer of service and must be replaced. The wearing process is accelerated during winter operations, when the deposit faces are frozen and extremely hard. When lenses of hard formation or boulders are encountered, often times the wheel cannot be stopped in time to prevent the teeth from breaking, which in turn causes a shut-down of the excavator for the purpose of replacing the teeth. Such a shut-down of excavators is extremely expensive. Some idea of the expense is obtained by considering the size of a bucket wheel excavator, which for example, is being used in the mining of tar sands. These particular excavators are 100 feet high from the bottom treads of their caterpillar crawlers to the top of their bucket wheel riggings. They are about 210 feet in length and weigh about 1700 tons each.

It is therefore an object of the present invention to provide a new and improved apparatus for excavating materials containing hard substances.

SUMMARY OF THE INVENTION

The present invention contemplates an excavator in the form of a shovel or a bucket wheel, which has a set of teeth for digging the material to be mined. Means are provided on the excavator for releasing the bucket from its earth engaging position and permitting recession of the bucket away from the face of the formation being excavated upon encountering, by the bucket, of unusually hard substances within the formation. When the bucket passes the formation face and proceeds to its downside arc in the wheel rotation, the bucket moves to its normal extended position for engaging the face of the earth formation. In addition, a mechanism may be provided on the bucket teeth for imparting a jarring blow to the hard materials when they are encountered. This mechanism has provisions for fast resetting, so that the jarring operation can be repeated when the bucket subsequently encounters hard materials in the formation.

A complete understanding of this invention may be had by reference to the following detailed description, when read in conjunction with the accompanying drawings illustrating embodiments thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of an excavator bucket wheel;

FIG. 2 is a partial view of a bucket wheel showing the bucket mounting and release mechanism in accordance with the present invention;

FIG. 3 is a cross-sectional drawing of the bucket release mechanism;

FIG. 4 is a rear view of a bucket mounted on a bucket wheel, and showing an alternative release mechanism arrangement; and

FIG. 5 is a cross sectional view of a bucket tooth having a jarring mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, FIG. 1 shows a side view of an excavator wheel **12** mounted on a boom **14**. This structure forms a part of an excavator apparatus, the remainder of which is not shown for the sake of simplicity. However, such apparatus normally would consist of a support structure adapted to rest on the ground, a turntable structure having a turning axis, and rotatably supported by the support structure, the working boom connected at one end of the turntable structure and projecting outwardly therefrom, and the bucket wheel **12**, which is rotatably mounted at one end of the working boom **14**. The support structure is normally mounted on wheels or tracks for moving the structure relative to the material being excavated. The apparatus also may include a conveying mechanism for moving earth materials excavated by the buckets to a location adjacent the excavator for removal. The bucket wheel is comprised of a circular frame **16**, rotatably mounted at the end of the boom, with buckets **18** having teeth **20** extending substantially outwardly from the periphery of the bucket for severing earth material as the bucket wheel is brought into a position for contacting the face of an exposed earth formation. The bucket is pivotally attached at pivot pin **21** to the wheel frame.

As shown in FIG. 2, a conventional bucket is generally V-shaped, when viewed from the side, and consists of a solid arcuate back wall **22**, solid side walls **24**, and a cutting lip **26** at the leading edge of the back and side walls. The lip of each bucket projects beyond the wheel rim **27**, and the lower end of the bucket extends slightly inwardly from the rim of the wheel. The excavator bucket or shovel has teeth mounted along the front and side lip thereof. Selected teeth **28** are provided with mechanisms for imparting a jarring blow to hard materials within the formation. A tang **31** extends rearwardly on each side of the bucket and has a lateral hole therein for receiving the pivot pin **21**, extending from the bucket wheel. A bucket stop **32** extends rearwardly from the lower end of the bucket and follows the arcuate line of the bottom side of the bucket. A bucket release mechanism is shown by the reference numeral **33** and includes a housing **34** for a hydraulic system, a piston rod **36** extending outwardly from the housing, and attached at its outer end to a pivoted stop member **37**. The opposite end of the pivoted stop member engages the rear sloping surface **38** (FIG. 3) of the bucket stop **32** to maintain the bucket in the position shown in FIG. 2.

Referring now to FIG. 3 of the drawings, the hydraulic release mechanism **33** is shown in greater detail. The mechanism includes the housing **34** for slidably receiving the lower end of the piston rod, and a piston **41** mounted thereon. A shoulder **42** at the upper end of the housing is provided with an O-ring seal **43** for sealingly engaging the outer surface of the piston rod **36**, which extends through an opening formed in the shoulder. The shoulder and seal at the upper end of the housing form a hydraulic chamber within the housing below the seal. The interior bore of the housing has a shoulder portion **40** formed therein which provides a small diameter bore **44** within the housing bore. The piston is sized in diameter to provide a restricted fluid flow path **46** between the shoulder portion and the exterior surface of the piston, which permits a controlled rate of fluid flow between the piston **41** and shoulder portion **40**. Passageways **47** are formed longitudinally through the piston and communicate its upper and lower ends. A check valve **48** is positioned in each of the passageways. The check valve permits fluid flow through the passageways **47** in a downward direction, but prevents flow in an upward direction. A compression spring **49** is positioned between the lower end of the piston and the bottom of the hydraulic chamber. A flange **51** is attached to the lower end of the housing **34** and extends outwardly therefrom to provide a means for connecting the hydraulic mechanism to the frame **16** by means of bolts or the like. The outer end of the piston rod has a transverse pin **52** extending from the rod. The stop member **37** is pivotally attached approximately midway between its ends to the bucket wheel frame **16** by means of a pin **53**. The lower end of the pivoted stop member **37** has a longitudinal slot **35** for receiving the transverse pin **52** on the end of the piston rod. A roller **54** is rotatably mounted on the opposite end of the pivoted stop member **37** and is arranged to engage the rear sloping surface **38** of the bucket stop **32**. An alarm **25** is shown in conjunction with the hydraulic release mechanism of FIG. 3. A switch **30** is arranged to be closed by movement of the pivoted stop member to a position releasing the bucket for inward movement into the wheel. The alarm may incorporate audible or visual devices to give the operator of the bucket wheel an indication that a hard substance has been encountered, and that a bucket has released. An electrical circuit (not shown) is provided to power the alarm device.

In the operation of the apparatus thus far described, the release mechanism in conjunction with the bucket is operated as follows: During normal excavating operations, as the bucket and teeth are brought into contact wth the earth materials, the materials are severed and gathered into the bucket, carried upwardly and around the the bucket wheel where they are dumped on a conveyor for removal away from the excavating machine. The roller **54** on the pivoted stop member **37** normally engages the rear sloping surface **38** on the bucket stop **32** to hold the bucket wheel in an operative position, as shown by the lower bucket in FIG. 2. The force generated by engaging the bucket with earth materials is transmitted to the pivoted stop member **37**. Such force in normal operations is not great enough during the time it takes to move through the face of the earth material, to actuate the release mechanism. However, if an unusually hard substance within the formation is encountered, the force imposed upon the teeth and bucket is transmitted to the stop member to rock the pivoted stop member about its pivot pin **53**. The motion of the bucket is transmitted through the pivot member and piston rod to the piston within the hydraulic chamber. A load on the bucket of sufficient magnitude and duration causes the piston rod and piston to move from right to left, as viewed in FIG. 3, within the hydraulic chamber. Hydraulic fluid within the chamber is displaced by the movement of the piston from the high pressure side of the piston through the restricted fluid flow path **46** between the piston **41** and the shoulder **40** to the low pressure side of the piston. This restricted passage of fluid permits a controlled and relatively slow rearward movement of the piston. Upon moving a predetermined distance, the piston **41** enters the enlarged diameter portion of the housing bore below the shoulder **40**. When the piston passes the shoulder **40**, piston and rod are permitted to accelerate. This in turn permits the bucket stop **32** to move the pivoted stop member **37** out of the way. The sloping surface **38** rides over the pivoted stop roller **54** to release the pivoted bucket **18** for movement into a recessed portion of the frame **16**. As the bucket moves rearwardly within the recessed portion of the wheel and the bucket stop **32** cams over the pivoted stop roller **54**, the arcuate movement of the lower end of the pivoted stop member **37** is permitted relative to the piston rod by means of the slot **35** in the end of the stop **37** riding on the transverse pin **52** in the end of the piston rod **36**. The alarm **25** is actuated by the arcuate movement of the lower end of the pivoted stop member **37** striking the switch **30** to indicate to the operator that a bucket has disengaged.

As the bucket moves away from the excavating position and rotates about the path of the bucket wheel, a restor-

ing mechanism operates to move the bucket to its normal operative position. When the bucket reaches the top side of its arc and starts a downside movement as illustrated by the upside down bucket of FIG. 1, the weight of the bucket tends to swing the bucket outwardly into its normal position about the pivot **21**. A stop member **56** (FIG. 2) extends outwardly from the rim of the bucket wheel to limit the movement of the bucket when it reaches its normal operative position. While the bucket is moving into this position, the pivoted stop member rolls along the underside of the bucket until it moves up the sloping surface **38** at the end of the bucket stop **32**. At this position, the bucket has reached its normal operating position, and is stopped by the stop member **56** from extending outwardly further from the bucket wheel. As the bucket wheel moves around its circular arc, the pivoted stop member is once again in a position to prevent the bucket from pivoting inwardly into the recessed wheel.

The spring **49** positioned between the piston **41** and the end of the housing, together with the hydraulic mechanism, serves as a means for maintaining the pivoted stop member against the bottom side of the bucket as the bucket returns to its extended position. The spring **49** urges the piston to return to its initial position for maintaining the bucket locked in its extended position. As the piston returns to its initial position as shown in FIG. 3, fluid is permitted to flow from right to left through the piston by means of passageways **47** which are checked to prevent flow in an opposite direction. This permits the rapid return of the piston to its initial position, and thus permits rapid resetting of the bucket to its extended position.

Referring next to FIG. 4 of the drawings, an alternative arrangement of the stop mechanism is shown. One of the hydraulic devices described above is positioned on each side of a bucket, with the hydraulic devices being precisely adjusted so that they are both tripped under the same load conditions to release the bucket. When the release mechanism of FIG. 4 is tripped, the lock or pivoted stop member **37** is cammed outwardly and rides along the side **24** of the bucket as the bucket recedes inwardly within the bucket wheel. Otherwise, the operation of the apparatus is the same as with respect to FIGS. 2 and 3.

Referring next to FIG. 5 of the drawings, a bucket tooth **28** is shown associated with a jar mechanism for imparting a jarring impact to hard materials which are encountered by the bucket during excavating operations. The mechanism includes the tooth **28**, which is mounted at the upper end of a mandrel **61**. A shoulder at the lower side of the tooth has a downwardly facing surface **63** which forms an anvil in the jarring device. A piston **64** is provided on the lower end of the mandrel. The piston is slidably received within the interior bore of a housing **66**. The housing is closed at its upper end by a shoulder **68** to form a hydraulic chamber in the housing. The shoulder **68** has an opening therein for receiving the mandrel. An O-ring seal **70** is positioned in the interior bore of the opening for sealingly engaging the outer surface of the mandrel. The top **72** of the shoulder forms a surface which serves as a hammer in the device. The interior bore of the housing has a shoulder portion **74** forming a small diameter portion at the upper end of the housing. The piston is sized in diameter to provide a restricted fluid flow path between the shoulder portion and the exterior surface of the piston which permits a controlled rate of fluid flow between the piston and shoulder portion similarly to the apparatus shown in FIG. 3. As with the apparatus of FIG. 3, passageways are formed longitudinally through the piston and communicate its lower and upper ends. A check valve is positioned in each of the passageways to permit fluid flow through the passage in a downward direction, while preventing flow in an upward direction. A compression spring **76** is positioned between the lower end of the piston **64** and the bottom of the hydraulic chamber.

In the operation of the apparatus just described, hydraulic fluid fills the chamber formed within the housing. During normal excavating operations, the load imposed upon the tooth **28** is not sufficiently great during the time the tooth is engaging earth materials, to cause the mandrel and piston to move downwardly within the chamber a sufficient distance to trip the jarring mechanism. However, if the load imposed upon the tooth **28** is great enough, the piston **64** moves downwardly within the hydraulic chamber with the fluid flowing from the bottom side of the piston through the restricted fluid flow path between the piston and the shoulder to the upper side of the piston. This restricted passage of fluid permits a controlled and relatively slow movement of the piston and tooth downwardly. Upon moving a predetermined distance, the piston enters the large diameter portion of the housing bore below the shoulder portion **74**, whereupon the movement of the piston and tooth is permitted to accelerate. The accelerated movement between the mandrel and housing is ended when the hammer **72** on the housing strikes the anvil surface **63** on the tooth to cause a jarring impact to be applied to the tooth. This impact is transmitted by the tooth to the earth formation, thereby breaking or loosening hard materials to permit their removal from the earth.

When the hard materials have been passed by the bucket tooth, the system restores the movable tooth to its normal operating condition. The compression spring **76** tends to force the piston **64** upwardly within the hydraulic chamber. The passageways and check valves (not shown) permit movement of the fluid from the upper side of the piston to the lower side through the piston, so that the piston may be rapidly restored to its initial position to facilitate a subsequent jarring operation. Such restoring action of the jarring mechanism is accomplished rapidly enough so that by the time the bucket wheel has completed a revolution to again bring the tooth into contact with the earth formation, the tooth will have been restored to its normal operating position.

When the jar mechanism is used in conjunction with the tooth, together with the releasing mechanism on the bucket, it is seen that the jarring mechanism should be regulated to actuate at a load less than that required to trip the bucket, so that the jarring mechanism is given a chance to impact and loosen the hard materials within the formation before the bucket itself is released as a safety measure for preventing breakage of bucket teeth.

While the excavating apparatus disclosed herein has been described in conjunction with a bucket wheel excavator, it is readily seen that such a release mechanism and jarring apparatus would have application to other types of earth handling devices. In addition, while particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects, and therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. An apparatus for excavating earth materials including a frame supported bucket, comprising: means for permitting relative movement between the bucket and frame; holding means for maintaining said bucket in a first position for excavating earth materials; means responsive to a load of predetermined magnitude being applied to said bucket for disengaging said holding means; and means for automatically re-engaging said holding means.

2. The apparatus of claim **1** wherein said holding means is a hydraulic delay mechanism.

3. The apparatus of claim **2** wherein said holding means further includes a piston slidably received in a hydraulic chamber, said chamber having a first portion

permitting restricted movement of said piston and a second portion permitting rapid movement of said piston.

4. An earth excavating apparatus comprising: a plurality of buckets mounted on a bucket wheel; means for rotatably supporting said bucket wheel and for positioning said bucket wheel relative to earth formations being excavated; means for releasably holding said buckets in an extended position relative to said wheel; means for disengaging said holding means to permit said bucket to move to an unextended position relative to said wheel, said buckets being restorable to said extended position; and means for re-engaging said holding means when said buckets are restored to said extended position.

5. The apparatus of claim 4 wherein said holding means is a hydraulic mechanism including a piston slidably received within a hydraulic chamber.

6. The apparatus of claim 5 wherein said chamber has a first portion permitting a restricted flow of fluid from one side of said piston to the other and a second portion permitting a relatively rapid flow of fluid from one side of said piston to the other when said piston is moved in one longitudinal direction in said chamber.

7. The apparatus of claim 6 and further including means for permitting a relatively rapid flow of fluid from said other side of said piston to said one side when said piston is moved in the other longitudinal direction in said chamber.

8. The apparatus of claim 7 and further including

means for urging said piston to move in said other longitudinal direction.

9. The apparatus of claim 4 wherein said holding means is comprised of a pair of hydraulically operated delay mechanisms each positioned at the side of said bucket.

10. The apparatus of claim 4 wherein said holding means is disengaged in response to a load of a predetermined magnitude being applied to said bucket, and further including teeth mounted on said bucket, and means for imparting a jarring force to said teeth in response to a load of a lesser magnitude than said predetermined magnitude being applied to said bucket.

11. The apparatus of claim 4 and further including alarm means operable when said holding means is disengaged.

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U.S. Cl. X.R.

37—142, 189; 299—67, 69