Sept. 29, 1959 W. S. MILLER 2,906,155

PLIERS WITH AUTOMATIC FULCRUM SHIFT

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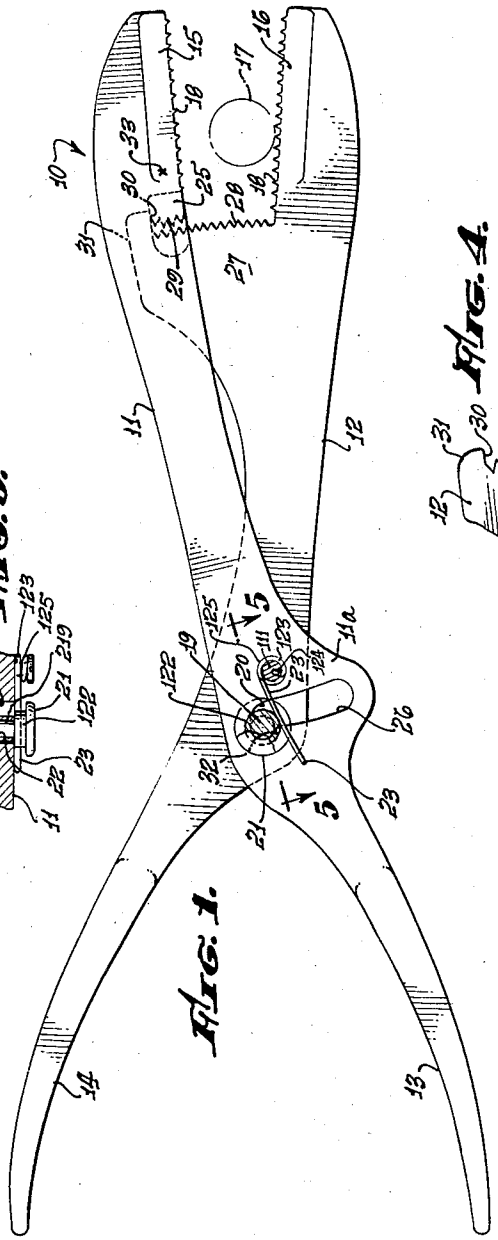


FIG. 1.

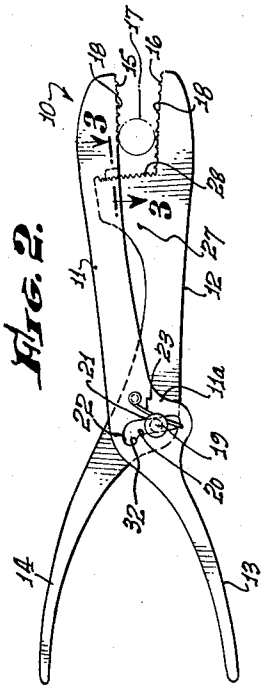


FIG. 2.

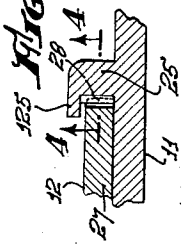


FIG. 3.

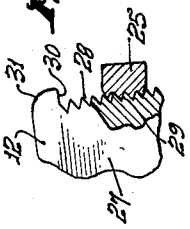


FIG. 4.

FIG. 5.

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Fig. 8.

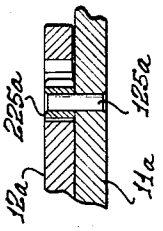


Fig. 6.

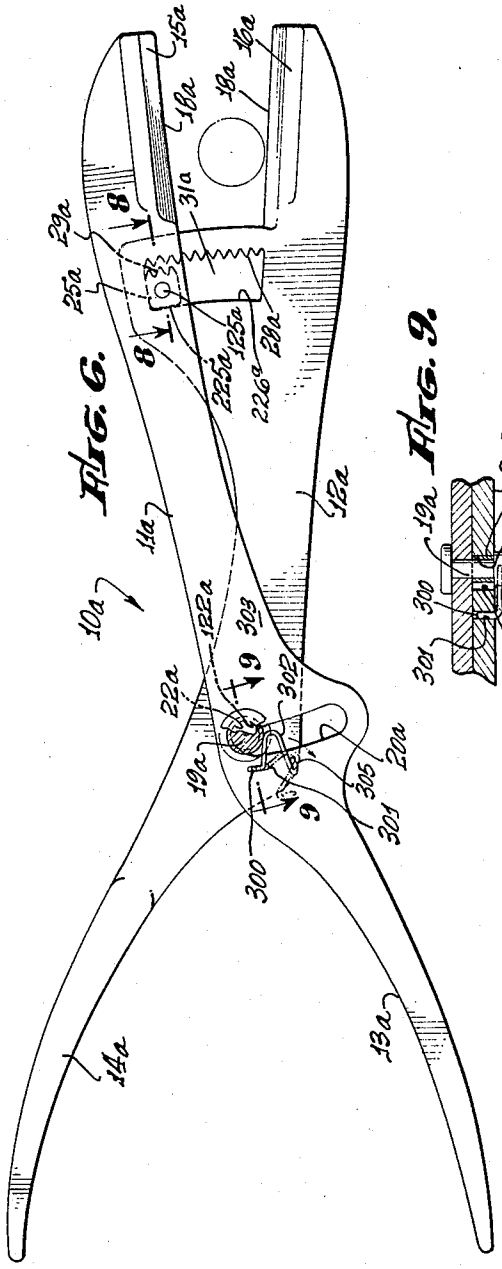


Fig. 9.

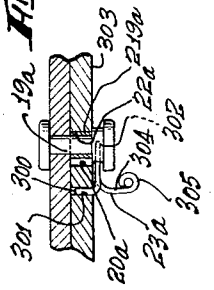
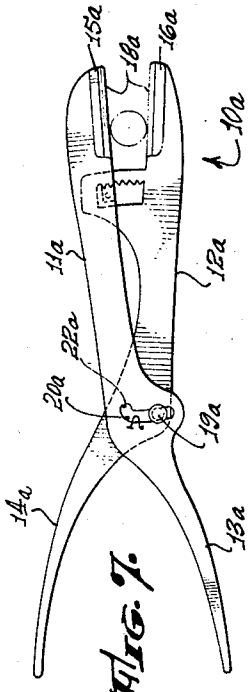


Fig. 7.



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PLIERS WITH AUTOMATIC FULCRUM SHIFT

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Application September 7, 1956, Serial No. 608,489
13 Claims. (Cl. 81—343)

This invention relates to improved pliers and similar hand tools, consisting of two pivotally interconnected elongated members having jaw portions at one end, and handle portions at their opposite ends for actuating the jaws. Where the term "jaw" is used in this application, it is contemplated these jaws may be either gripping elements for tightly holding a work piece, or cutting elements for cutting the work piece.

The general object of the invention is to provide a new type tool of this general character which is automatically adjustable to different conditions for most effectively gripping or acting against different sizes of work piece. More specifically, the tool acts by itself, and during a closing operation, to shift from one condition to another at a proper time for most effectively engaging the particular work piece being handled. During the initial portion of a closing movement, the jaws may close relatively rapidly in relation to movement of the handles, but with little force. Then, after engagement with the work piece, the tool may shift to a condition in which a much greater force is applied to the jaws, with the handles automatically being adjusted, by said shifting of conditions, in a manner maintaining the handles within a desired range of movement when the work piece is actually being gripped.

To achieve this automatic adjustment of the tool, the two sections of the tool are adapted to swing or pivot relative to one another about either of two different pivot points or axes. During the initial portion of a closing movement, the sections pivot about a first of these axes, which may be relatively far from the work engaging jaws; and then when a work piece is engaged by the jaws and resists further closing movement, the parts automatically adjust to a condition in which they pivot about a second center which is closer to the jaws and work piece. The pivotal connection at the first center may be constructed to slip transversely of its axis when the work piece is engaged, and that slippage can then cam one of the two sections longitudinally in a manner rendering a shiftable pivot part near the jaws effective as a fulcrum element.

Certain particular and highly important features of the invention have to do with the manner of construction of the first or primary pivotal connection, that is, the connection which is effective during the first part of a closing operation. Specifically, this connection may include a pivot pin which is carried by one of the two pivoted sections of the device, and which extends through an elongated slot in the other section. The pin is confined within a predetermined end or portion of the slot during the first part of a closing operation, and then slips from that location and along the slot when a work piece resists further closure of the jaws. The slot is so shaped as to cam the two sections longitudinally relative to each other when the pin thus slips along the slot, to thereby render the second pivotal or swinging connection effective. When such a pin and slot connection is employed, the two members can be very effectively held in assembled relation by merely providing a head on the pin at an outer side of the slot and of a size incapable of passing through the slot. Preferably, the pin is releasably retained in its initial position in the slot by suitable yielding or detent means, as by a suitable spring acting against the pin. In one form of the invention, this spring detent

will function also to releasably retain the pin against returning movement toward its initial position after having been shifted therefrom, and until a user purposely releases the detent to allow such returning movement.

The second pivotal connection may include a pivot part on one of the jaws which is engageable in any of different positions with a series of teeth on the other jaw. This secondary pivot part may be a toothed lug on the associated jaw adapted to act as a fulcrum member when in engagement with the coacting series of teeth. As will be brought out, the range of required swinging movement of the two members about the second center is very small, and therefore this secondary pivot part or fulcrum member need not be designed to allow any extended range of pivotal movement.

A further feature of the invention resides in the preferred positioning and formation of the holding teeth which are engaged by the secondary pivot part to form the secondary pivotal connection. Specifically, these teeth may be formed on one of the jaw sections of the device, at a location facing essentially toward the location at which a work piece is received between the jaws.

The above and other features and objects of the present invention will be better understood from the following detailed description of the typical embodiments illustrated in the accompanying drawings in which:

Fig. 1 is a side view of a pair of pliers constructed in accordance with the invention, and showing the pliers in their fully open position;

Fig. 2 is a smaller view similar to Fig. 1, but showing the pliers in a gripping condition;

Fig. 3 is an enlarged fragmentary section taken on line 3—3 of Fig. 2;

Fig. 4 is a fragmentary section taken on line 4—4 of Fig. 3;

Fig. 5 is a fragmentary section taken on line 5—5 of Fig. 1;

Fig. 6 is a view corresponding to Fig. 1, but showing a variational form of the invention;

Fig. 7 is a view showing the Fig. 6 device in its active gripping or cutting condition;

Fig. 8 is a fragmentary section taken on line 8—8 of Fig. 6; and

Fig. 9 is a fragmentary section taken on line 9—9 of Fig. 6.

In the drawings, the tool **10** includes two elongated rigid metal members **11** and **12**, which have first handle ends **13** and **14** adapted to be actuated toward and away from each other, and second jaw ends **15** and **16** for gripping a work piece **17** in response to actuation of handle ends **13** and **14**. The jaws **15** and **16** of course may be provided with the usual irregularities or teeth **18**, for assuring effective gripping of the work piece. The two handle ends **13** and **14** are so relatively positioned as to be receivable within the hand of a user, to be manually actuated toward and away from each other in the manner of conventional pliers.

Member **12** rigidly carries a pivot pin **19**, which preferably extends directly transversely of members **11** and **12**, and whose reduced cylindrical portion **119** may be a tight pressed fit within an opening **120** in member **12**. Portion **119** of the pin projects transversely beyond member **12**, and is movably received within a slot **20** formed in a somewhat enlarged portion **11***a* of member **11**, the slot having a width which is only slightly larger than the diameter of a bearing sleeve **219** received about pin portion **119**. At its opposite ends, pin **19** may have a pair of enlarged circular heads **21** and **121**; and between head **21** and portion **119**, pin **19** may have an intermediate size cylindrical portion **122**. The diameters of portion **122** and **21** and **121** are all greater than the width of slot **20** and the diameter of opening **120**, so that

members 11 and 12 are at all times confined between portions 122 and 121 of the pin, to retain members 11 and 12 in assembled condition.

Slot 20 has an end portion 22 which curves in a direction away from the jaw end 15 of part 11, and which forms a partial cylindrical bearing surface at the end of the slot for engaging bearing sleeve 219 on pin 19 in the Fig. 1 condition of the tool, to form with pin 19 and its sleeve 219 a pivotal connection attaching parts 11 and 12 together for relative swinging or pivotal movement about the axis of pin 19. The pin is yieldingly retained in the illustrated Fig. 1 position within the end portion 22 of slot 20 by means of a spring 23, one of whose ends 123 is retained in fixed relation to member 11, as by reception within a transverse slot 124 formed in a pin 111 (the spring end typically being a tight pressed fit in slot 124). The spring has a coiled portion 125, extending about pin 111, and then projects past pin 19, in engagement with its enlarged portion 122, to yieldingly hold the pin within end 22 of the slot. Except at its turned end 22, slot 20 extends arcuately about essentially the location of a secondary pivot part 25 which is carried by member 11 near its jaw end, and which will be discussed in greater detail at a later point. Upon movement of pin 19 from end 22 of slot 20, toward its opposite end, spring 23 is yieldingly deflected, as to the position of Fig. 2.

Member 12 has near its jaw end 18 a laterally enlarged portion 27, which carries an arcuate series of teeth 28 facing essentially toward the jaw end of member 12 and centered about the axis of pin 19. The previously mentioned pivot part 25 carried by member 11 has a series of similar teeth 29 which are engageable with teeth 28 by longitudinal shifting movement of member 11 relative to member 12, and which act to prevent relative pivotal movement of members 11 and 12 about the axis of pin 19 when teeth 29 are engaged with teeth 28. Pivot part 25 may typically be formed as an integral lug or projection on member 11, and may have a side shoulder engageable at 30 with an end projection 31 on portion 27 of member 12, to limit the relative separating movement of jaws 15 and 16 at the Fig. 1 position. Also, lug 25 may have a portion 125 projecting to a position overlying the toothed portion 28 of part 12, to assist in retaining parts 11 and 12 against one another.

As long as teeth 29 and 28 are not engaged, members 11 and 12 can pivot freely about pin 19.

To now describe the operation of the device, assume that it is desired to grip the work piece 17 between jaws 15 and 16 of tool 10. In order to perform this operation, the user first places part 17 between the jaws, and then commences to manually actuate handle elements 13 and 14 relatively together. During the first portion of the movement of handles 13 and 14 toward one another, these handles and the rest of parts 11 and 12 pivot freely about the axis of pin 19, which is then received within the end portion 22 of slot 20. During such initial pivotal movement, pivot part 25 is held out of engagement with teeth 28, thus permitting free swinging movement of the jaw ends about pin 19.

When the pivotal closing movement has reached the point at which jaws 15 and 16 engage opposite sides of work piece 17, the work piece resists further closing movement of the jaws, and therefore any further closing movement of handles 13 and 14 will cause pin 19 and its bushing 219 to be displaced from end portion 22 of slot 20, against the tendency of spring 23, and to then progressively move along slot 20 toward its opposite end. Since the end portion 22 of slot 20 is curved away from the jaw end of member 11, the wall of the slot forms a curving cam surface at 32, whose engagement with bushing 219 acts to progressively cam member 11 longitudinally relative to pin 19 as the pin slips out of end portion 22 of slot 20 and into its arcuate portions 26. This longitudinal camming movement of member 11 is just

sufficient to move the teeth 29 of pivot part 25 into meshing engagement with teeth 28 of member 12, to prevent further closing movement of pivot part 25 relative to teeth 28.

After part 25 has thus been moved into engagement with teeth 28, any further relative closing movement of members 11 and 12 must be about essentially the pivot part 25 as a pivotal axis or fulcrum. Thus, the pivotal connection between members 11 and 12 is automatically moved from the location of pin 19 to the location of pivot part 25, in response to engagement of jaws 15 and 16 with work piece 17. Upon further closure of handles 13 and 14, the jaws move very slowly as compared with the movement of the handles, but with great force or leverage being applied against the work piece. In order to allow for the necessary pivotal movement of members 11 and 12 about pivot part 25, the teeth 29 of part 25 may extend along an essentially curved path, which is curved oppositely to the arcuate curvature of teeth 28, the teeth 29 typically being curved about an axis represented at 33. Thus, during the relatively slight pivotal movement about part 25, the teeth 29 are capable of rolling slightly along teeth 38, to permit the specified pivotal movement. After the gripping operation is completed, handles 13 and 14 may be moved sufficiently far apart to return part 19 into end 22 of slot 20, in preparation for the next gripping action. As will be apparent, the device is operative in the discussed manner to grip work pieces of any desired size, and regardless of the size of the piece, the jaws will pivot about pin 19 until the work piece is contacted, and will then automatically shift to a condition in which they pivot essentially about part 25, for increased gripping force in an automatically adjusted condition.

Figs. 6 to 9 show a tool which is essentially very similar to that of Figs. 1 to 5, differing only in the respects discussed specifically in the following description. This Fig. 6 tool 10*a* includes two elongated rigid members 11*a* and 12*a*, having handle ends 13*a* and 14*a*, and jaw ends 15*a* and 16*a*. In this case, the jaws 15*a* and 16*a* have typically been represented as being cutter blades rather than gripping jaws, the blades having sharp cutting edges at 18*a* for cutting into or through a work piece. The member 12*a* carries a pivot pin 19*a* which is received within an end portion 22*a* of an arcuate slot 20*a* centered essentially about pivot part 25*a*. Pin 19*a* and its bushing 219*a* are yieldingly retained within the end portion 22*a* of slot 20*a* by means of a detent element 23*a* which is formed of a single elongated piece of spring wire bent to the illustrated configuration. This spring has a first U-shaped or doubled back portion 300 which is received and held in fixed position within a slot 301 in member 11*a*. Beyond portion 300, wire 23*a* has a second U-shaped portion 302, which extends parallel to and adjacent to the outer surface 303 of part 11*a*, and which normally returns to the position of Fig. 6 across the path of pin 21 of bushing 219*a*. At its outer end, wire 23*a* has a portion 304 projecting transversely away from part 11*a*, and carrying a loop 305 by which the U-shaped portion 302 may be manually retractable to the broken line position of Fig. 6.

Pin 19*a* can only move into the arcuate portion of slot 20*a* by deflection of portion 302 of part 23*a* to this broken line position; and after pin 19*a* moves past detent 23*a*, the latter resiliently returns to the Fig. 6 full line position to prevent return of pin 19*a* past the detent until the detent is manually released to the broken line position by movement of loop 305.

As seen clearly in Fig. 6, the end portion 22*a* of slot 20*a* corresponds to portion 22 of slot 20, except that in Fig. 6 the end portion of the slot curves toward the jaw end 15*a* of member 11*a*, rather than toward its handle end as in Fig. 1. Thus, the member 11*a* is shifted longitudinally toward its jaw end, rather than its handle end, when pin 19*a* moves out of the end portion 22*a*

of the slot. In order to render pivot part 25*a* effective as a fulcrum element upon such longitudinal shifting of member 11*a*, the teeth 29*a* on pivot part 25*a*, and the arcuate series of teeth 28*a* on member 12*a*, face in opposite directions than in Fig. 1. Pivot part 25*a* may be received within an essentially arcuate slot 31*a*, so that swinging movement of pivot part 25*a* is limited by engagement of that part with the ends of the slot. Also, in Fig. 6, the pivot part is typically shown as being pivotally mounted about a pin 125*a*, which is rigidly attached to member 11*a*. The arcuate series of teeth 28*a* may be centered about the axis of pin 19*a*, and the teeth 29*a* may be centered about that axis when pivot part 25*a* is in its Fig. 6 position. The pin 125*a* about which part 25*a* is received may of course have a suitable enlarged head represented at 225*a* for holding part 25*a* against separation from member 11*a*. Also, the pivot part 25*a* may have an arcuate surface 225*a* centered about the axis of pin 19*a*, and slideably engageable with an arcuate correspondingly centered surface 226*a* on member 12*a* (at the inner side of slot 31*a*) to hold the pivot part 25*a* against turning movement relative to part 12*a* from the illustrated properly oriented position.

In using the Fig. 6 device, pin 19*a* remains within end 22*a* of slot 20*a* during the initial closing movement of handles 13*a* and 14*a* and cutting jaws 15*a* and 16*a*. When the jaws engage a work piece, the resistance offered by that work piece causes pin 19*a* and its bushing 219 to deflect detent element 23*a* and move into the elongated arcuate portion of slot 20*a*, with the pin and member 11*a* being cammed longitudinally by virtue of the engagement of the bushing 219 with cam surface 122*a*. This longitudinal movement of member 11*a* moves pivot part 25*a* into engagement with teeth 28*a*, so that thereafter the members 11*a* and 12*a* are hinged at pivot part 25*a* rather than the pin 19*a*, to increase the leverage exerted against the work piece. This allows the user to apply a relatively great cutting force to the work piece through blades 15*a* and 16*a*, though of course the blades will not normally close on a single actuation. Repeated cutting actions may be effected in this manner, with the tool each time automatically adjusting the jaws to a slightly more closed condition before pivot part 25*a* moves to active position, so that the cutting actions may progressively cut deeper and deeper through the work piece. After each cutting action, the detent part 23*a* is of course manually released to permit return of pin 19*a* to its Fig. 6 position.

I claim:

1. A plier type tool comprising two elongated rigid relatively pivotable members having handles at their first ends movable toward and away from each other and having jaws at their opposite ends actuable toward and away from each other and against a work piece by said movement of the handle ends, a first of said members containing a slot between said handle and jaw ends thereof, a pivot pin on the second member received within an end of said slot during initial closing movement of the members and thereby forming a first pivotal connection between the members, said slot extending in a direction to permit passage of said pin along the slot and away from said end of the slot when a work piece resists closing movement of the jaws, said pivot pin being secured to said first member against separation therefrom and having an enlarged head at an outer side of said slot and wider than the slot to hold said two members together, said slot being defined by a pair of spaced edge surfaces extending along opposite sides of the slot and engageable with opposite sides of said pin to confine it for movement along the slot, one of said edge surfaces being shaped to cam said pin in a direction to shift said second member generally longitudinally relative to said first member in response to said movement of the pin from said end of the slot, an additional pivot part carried by one of the members at a location closer to its jaw end than is said first pivotal connection and movable in a closing direction relative to the other member during said initial closing movement of the jaws, and an arcuate series of teeth on said other member engageable with said additional pivot part in response to said relative camming of the members by the slot and pin and operable to then form with said pivot part a second connection interconnecting said members for relative swinging movement about a location closer to the jaws than is said first connection, said slot having an essentially arcuate portion along which said pin moves after the pin shifts from said end of the slot.

2. A plier type tool comprising two elongated rigid relatively pivotable members having handles at their first ends movable toward and away from each other and having jaws at their opposite ends actuable toward and away from each other and against a work piece by said movement of the handle ends, a first of said members containing a slot between said handle and jaw ends thereof, a pivot pin on the second member received within an end of said slot during initial closing movement of the members and thereby forming a first pivotal connection between the members, said slot extending in a direction to permit passage of said pin along the slot and away from said end of the slot when a work piece resists closing movement of the jaws, said pivot pin being secured to said first member against separation therefrom and having an enlarged head at an outer side of said slot and wider than the slot to hold said two members together, said slot being defined by a pair of spaced edge surfaces extending along opposite sides of the slot and engageable with opposite sides of said pin to confine it for movement along the slot, one of said edge surfaces being shaped to cam said pin in a direction to shift said second member generally longitudinally relative to said first member in response to said movement of the pin from said end of the slot, an additional pivot part carried by one of the members at a location closer to its jaw end than is said first pivotal connection and movable in a closing direction relative to the other member during said initial closing movement of the jaws, an arcuate series of teeth on said other member engageable with said additional pivot part in response to said relative camming of the members by the slot and pin and operable to then form with said pivot part a second connection interconnecting said members for relative swinging movement about a location closer to the jaws than is said first connection, said slot having an essentially arcuate portion along which said pin moves after the pin shifts from said end of the slot, and means pivotally attaching said pivot part to said one member, said other member containing an arcuate slot within which said pivot part is received and having at one of its sides an arcuate series of teeth engageable in holding relation and in different positions with said pivot part, said last mentioned slot having along a second of its sides an arcuate guide surface slidably engaging a surface on said pivot part to hold it in predetermined relation to said other member.

3. A plier type tool comprising two elongated rigid relatively pivotable members having handles at their first ends movable toward and away from each other and having jaws at their opposite ends actuable toward and away from each other and against a work piece by said movement of the handle ends, a first of said members containing a slot between said handle and jaw ends thereof, a pivot pin on the second member received within a predetermined portion of said slot during initial closing movement of the members and thereby forming a first pivotal connection between the members, said slot extending in a direction to permit passage of said pin along the slot and away from said predetermined portion of the slot when a work piece resists closing movement of the jaws, said slot being defined by a pair

of spaced edge surfaces extending along opposite sides of the slot and engageable with opposite sides of said pin to confine it for movement along the slot, one of said edge surfaces being shaped to cam said pin in a direction to shift said second member generally longitudinally relative to said first member in response to said movement of the pin along the slot and away from said predetermined portion of the slot, an additional pivot part carried by one of the members at a location closer to its jaw end than is said first pivotal connection and movable in a closing direction relative to the other member during said initial closing movement of the jaws, holding means on said other member engageable with said additional pivot part in response to said relative camming of the members by the slot and pin and operable to then form with said pivot part a second connection interconnecting said members for relative swinging movement about a location closer to the jaws than is said first connection, and a spring detent unit yieldingly retaining said pin in said predetermined portion of the slot until the jaws engage a work piece and then deflectible to permit passage of the pin along the slot to effect said longitudinal camming of said second member, said spring unit then being operable to releasably hold said pin against returning movement to its initial position in said predetermined portion of the slot.

4. A plier type tool comprising two elongated rigid relatively pivotable members having handles at their first ends movable toward and away from each other and having jaws at their opposite ends actuable toward and away from each other and against a work piece by said movement of the handle ends, a first of said members containing a slot between said handle and jaw ends thereof, a pivot pin on the second member received within a predetermined portion of said slot during initial closing movement of the members and thereby forming a first pivotal connection between the members, said slot extending in a direction to permit passage of said pin along the slot and away from said predetermined portion of the slot when a work piece resists closing movement of the jaws, said slot being defined by a pair of spaced edge surfaces extending along opposite sides of the slot and engageable with opposite sides of said pin to confine it for movement along the slot, one of said edge surfaces being shaped to cam said pin in a direction to shift said second member generally longitudinally relative to said first member in response to said movement of the pin along the slot and away from said predetermined portion of the slot, an additional pivot part carried by said first member at a location closer to its jaw end than is said first pivotal connection and movable in a closing direction relative to the second member during said initial closing movement of the jaws, and holding means on said second member engageable with said additional pivot part in response to said relative camming of the members by the slot and pin and operable to then form with said pivot part a second connection interconnecting said members for relative swinging movement about a location closer to the jaws than is said first connection, said pivot pin having a head at an outer side of said slot and projecting laterally beyond at least one of said edge surfaces of the slot and overlying a portion of said first member adjacent the slot to hold said two members together.

5. A plier type tool as recited in claim 4, including means yieldingly retaining said pin in said predetermined portion of the slot until the jaws engage a work piece.

6. A plier type tool as recited in claim 4, including a spring yieldingly resisting said movement of the pin along the slot from said predetermined portion thereof and continuously urging said pin back toward said predetermined portion of the slot after displacement therefrom.

7. A plier type tool as recited in claim 4, in which said holding means comprise a series of teeth carried by said second member and engageable with said pivot part in holding relation in any of different positions.

8. A plier type tool as recited in claim 4, in which said holding means comprise a series of teeth on said second member engageable with said pivot part in any of different positions, there being means pivotally attaching said pivot part to said first member.

9. A plier type tool as recited in claim 4, in which said holding means comprise a series of teeth on said second member, and said pivot part is an integral lug on said first member rigidly fixed relative thereto and engageable in holding relation and in different positions with said first mentioned teeth.

10. A plier type tool as recited in claim 4, in which said second member contains an arcuate slot within which said pivot part is received and arcuately movable, said holding means comprising an arcuate series of teeth formed along a side of said last mentioned slot and engageable with said pivot part in holding relation.

11. A plier type tool as recited in claim 4, including a spring detent element formed of a resilient wire attached at one point to said first member and constructed to yieldingly resist movement of the pin along the slot between said predetermined portion thereof and the rest of the slot, said detent element having a portion projecting to a location accessible to a user's hand and adapted to be moved by said hand, and adapted by said movement to release the detent to permit movement of the pin between said predetermined portion of the slot and the rest of the slot.

12. A plier type tool comprising two elongated rigid relatively pivotable members having handles at their first ends movable toward and away from each other and having jaws at their opposite ends actuable toward and away from each other and against a work piece by said movement of the handle ends, a first of said members containing a slot between said handle and jaw ends thereof, a pivot pin on the second member received within a predetermined portion of said slot during initial closing movement of the members and thereby forming a first pivotal connection between the members, said slot extending in a direction to permit passage of said pin along the slot and away from said predetermined portion of the slot when a work piece resists closing movement of the jaws, said slot being defined by a pair of spaced edge surfaces extending along opposite sides of the slot and engageable with opposite sides of said pin to confine it for movement along the slot, one of said edge surfaces being shaped to cam said pin in a direction to shift said second member generally longitudinally relative to said first member in response to said movement of the pin along the slot and away from said predetermined portion of the slot, an additional pivot part carried by said first member at a location near its jaw end and movable in a closing direction relative to the other member during said initial closing movement of the jaws, and a series of teeth formed on said second member and facing essentially away from said slot and toward the space between said jaws and positioned to be engaged by said additional pivot part in response to said relative camming of the members by the slot and pin and operable to then form with said additional pivot part a second connection interconnecting said members for relative swinging movement about a location closer to the jaws than is said first connection.

13. A plier type tool as recited in claim 12, in which said pivot part is a lug on said first member stationarily and rigidly fixed relative thereto and having teeth engageable with said first mentioned teeth in different positions, said first mentioned series of teeth being arcuate and centered essentially about said pin.

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