Feb. 1, 1938. C. G. A. ROSEN 2,106,920

ENGINE

Filed Dec. 26, 1933 2 Sheets-Sheet 1

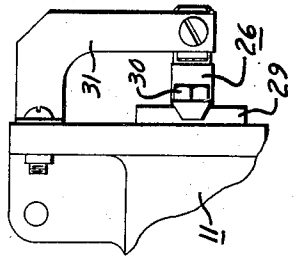


Fig. 2.

Fig. 1.

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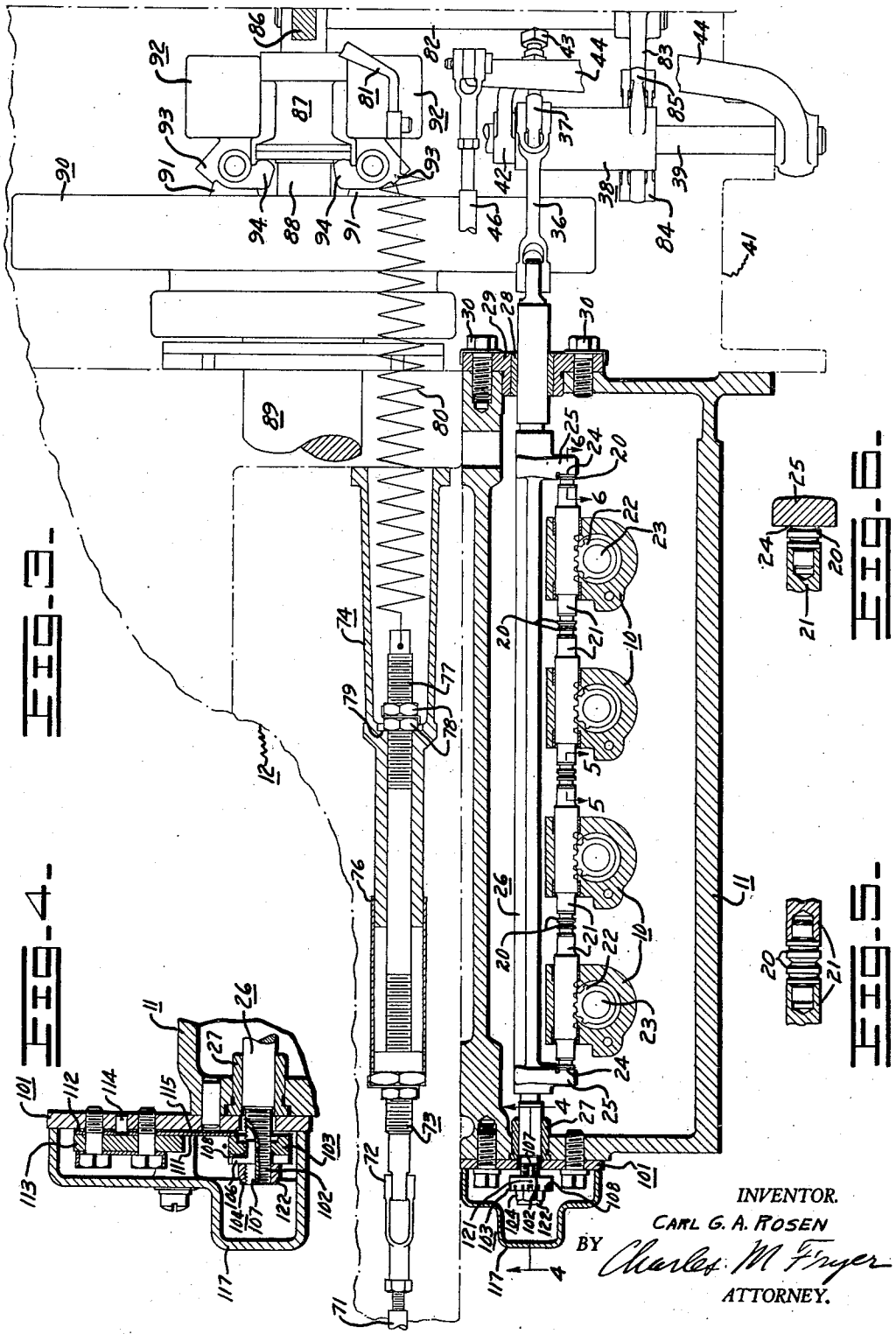


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

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ENGINE

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Application December 26, 1933, Serial No. 703,929

2 Claims. (Cl. 123—140)

Statement of invention

The present invention relates to compression ignition and the like engines, and more particularly to the provision of improved control means for the fuel metering means of the engines.

It is an object of the invention to provide a simple, economical and improved type of connecting means between the fuel metering means of compression ignition and the like engines and the governor or throttle control therefor.

Another object of the invention is to provide an improved type of control member adapted for connection to the adjustable elements of the fuel metering means of compression ignition and the like engines, in which the connection between said member and said elements can be made in a facile manner, and without adjustment of any of the parts.

Another object of the invention is to provide a control member adapted for connection to the adjustable elements of the fuel metering means of compression ignition and the like engines, in which an improved connection is established solely by virtue of the mounting of the fuel metering means and the control member on the engine.

Another object of the invention is to provide, in a compression ignition and the like engine, improved mechanism adapting the engine for satisfactory operation at varying altitudes.

Another object of the invention is to provide an improved method of manufacture and assembly of the fuel control means in compression ignition and the like engines, enabling a simple adjustment to compensate for operation of said engine at various altitudes.

Other objects will appear as the description progresses.

Description of figures

Fig. 1 is a fragmentary side elevation of the engine, illustrating the fuel injection pumps and the control means therefor.

Fig. 2 is a fragmentary elevational view, illustrating an attachment for maintaining the throttle slide bar of the control means in fixed position after assembly thereof with the fuel pumps, and before assembly of the fuel pump housing on the engine.

Fig. 3 is a sectional view taken on the line 3—3 in Fig. 1; the governing means being shown schematically.

Fig. 4 is a fragmentary section taken on the line 4—4 in Fig. 3.

Figs. 5 and 6 are fragmentary sections taken, respectively, on lines 5—5 and 6—6 in Fig. 3.

Description of mechanism

The compression ignition and the like engine is preferably provided with a fuel injection system of the solid injection type, that is, a system in which air free fuel is injected into the cylinders in the form of a finely divided spray, caused by forcing fuel at a high pressure through the fuel injection nozzles. A fuel injection nozzle is provided for each cylinder of the engine, and fuel is forced through said nozzles from a like number of fuel injection pumps, to which fuel is supplied through a common manifold.

The fuel injection pumps are preferably mounted in a housing which is detachably secured to the block of the engine; and the housing also provides a mounting for the pump control linkage in the form of a unitary member which is connected to adjustable control elements of the pumps. My copending application, Serial No. 691,640, filed September 30, 1933, describes in greater detail the fuel injection system; hence, only the parts of such system desirable for an understanding of the instant invention will be described herein.

A plurality of fuel injection pumps 10 (Fig. 1) are mounted in aligned relation in fuel pump housing 11 detachably mounted on engine block 12 by suitable fastening means. From each pump 10, a discharge conduit 13 leads to the associated fuel injection nozzle (not shown). Fuel manifold 16 is suitably mounted in housing 11 and extends along pumps 10, being secured to each pump by suitable fastening means 17. Fuel is supplied under pressure to fuel manifold 16 through a suitable filter and a suitable fuel transfer pump (both not shown), preferably mounted on housing 11. Covers 18, 19, are shown over apertures in housing 11 in place of the fuel filter and the fuel transfer pump, respectively.

Fuel injection pumps 10 are of the type adapted to force measured quantities of fuel through the associated conduits and fuel injection nozzles, and have movable control racks or elements by means of which the fuel metering means of the pumps are adjusted to determine the amount of fuel injected. The fuel metering means of each pump is preferably in the form of a rotatably mounted plunger which is reciprocated by suitable connections from a camshaft, mounted in housing 11 and driven in a timed relation from the crankshaft of the engine. The control racks of all the fuel injection pumps are actuated simultaneously to adjust or rotate the pump plungers about their longitudinal axes in accord-

ance with the throttle setting, and with the action of the governing means in response to engine demand. Each pump plunger is of the known type having a slanting by-pass ledge, the angular position of which determines the quantity of fuel injected.

Pumps 10 (Fig. 3) have each metering control element or rack 21 mounted for longitudinal reciprocation therein. The toothed portion of each control rack engages rotatable pump element 22 which is in the form of a sleeve operatively engaged with pump plunger 23; the rotated or angular position of which, as previously explained, determining the amount of fuel measured by the pump. Racks 21 are precalibrated in the manner disclosed in my copending application, Serial No. 696,960, filed November 7, 1933, to obtain uniform control of the pumps, and are of the same length from end to end. As seen in Fig. 3, racks 21 are disposed in end to end relation between machined faces 24 (Fig. 6) on ears or projections 25 of integral pump control bar or member 26 slidably mounted in housing 11. Hardened buttons or inserts 20 of predetermined size provide the ends of racks 21 and have flat end faces normal to the axis of reciprocation of the racks and in surface to surface contact, as can be seen in Fig. 5. Thus, movement of slide bar 26 simultaneously controls the various pumps to determine the amount of fuel injected. As viewed in Fig. 3, movement of bar 26 to the right increases the amount of fuel measured by the pumps. Bar 26 is mounted for sliding movement at its left end in bushing 27 suitably mounted in housing 11, and at its other end in bushing 28 mounted in bracket 29 secured to housing 11 by cap screws 30.

From the preceding description of applicant's control mechanism, it will be noted that the slide bar 26, since it has thereon the spaced apart means or ears 25 for maintaining the rack elements in free abutting relationship, provides with such spaced apart means, a structure substantially the shape of a C, and may hence be termed a C-clamp.

From the foregoing description, it is seen that pump control bar 26 is mounted for reciprocation along an axis parallel to the axis of reciprocation of the rack elements 21 and provides a compact and simple yet positive connection from the control means to the pumps; and its construction, mounting, and connections to the pump control elements or racks provide many advantages. It will be noted that racks 21 are connected to bar 26 for simultaneous movement therewith solely by virtue of contacting faces thereof, when pumps 10 and bar 26 are mounted in housing 11; the operation of mounting said pumps 10 and bar 26 being the only operation necessary to establish the connection from racks 21 to said bar 26. It is seen also that the linkage is characterized by the absence of adjustments, and by the absence of any pivoted joints or other similar connections which eventually would wear and prevent uniform, simultaneous movement of all the metering control elements. The described features not only contribute to economical manufacture and assembly, but also facilitate servicing, as any pump can be removed and replaced easily; pumps 10 being completely interchangeable.

When pumps 10 and bar 26 are assembled in housing 11, and before assembly of housing 11 on the engine, connection 31 (Fig. 2) is secured to bar 26 and to housing 11 by suitable fastening means to prevent movement of bar 26. Thus, bar 26 and the associated parts cannot be damaged due to accidental movement thereof before connection to the control means therefor. Connection 31 is, of course, removed upon assembly of the actuating linkage to bar 26.

A pair of hand control levers are connected to pump control bar 26 to control fuel injection. One of the control levers is only for the purpose of setting the pumps in proper position when it is desired to start the engine and for shutting off the pumps when it is intended to stop the engine. The other of the control levers provides a hand control for regulating engine speed and is connected with the governor of the engine.

After assembly of housing 11 on the engine, the right or front end of slide bar 26 with connection 31 removed, as viewed in Figs. 1 and 3, is pivotally connected to an end of link 36 having its other end pivotally connected to arm 37 extending upwardly from sleeve 38 pivotally mounted on shaft 39. Shaft 39 is suitably supported in timing gear housing 41 shown in phantom lines. Keyed on shaft 39 for rotation therewith is arm 42 having adjusting screw 43, threaded in the upper end thereof and abutting arm 37. Shaft 39 (Fig. 3) extends outside of timing gear housing 41 and has bent arm 44 secured thereon (Figs. 1 and 3). Arm 44 has adjustable rod 46 pivotally secured to the free end thereof, rod 46 extending rearwardly (Fig. 1) and having a pivotal connection with arm 47 secured on shaft 48. Shaft 48 is suitably supported on block 12 and has shorter arm 49 secured thereon, and having its upper end pivotally connected to rod 51. Rod 51 has its rearward end pivotally connected to arm 52 of the engine starting control lever 53 which is pivotally mounted on shaft 54 in bracket 56. Oscillation of lever 53 to the extreme right, as viewed in Fig. 1, through lever 44 and the connecting lever system, serves to rock shaft 39 and arm 42 to move pump control bar 26 to the left, as viewed in Fig. 3 to shut off pumps 10. In the left-hand position thereof, control lever 53 sets or enables pumps 10 for operation under control of both the governor, and a manually adjustable engine speed throttle control linkage. As was previously explained, hand lever 53 is only operated in starting and stopping of the engine.

The governor is of any suitable construction and has resilient means adjusted by the setting of a manually operable throttle control linkage, and centrifugal means rotated by the engine to act in opposition to said resilient means. The resilient and centrifugal means are connected to the pump control bar 26 so that, according to the tension placed on the resilient means, the governor acts automatically to control the fuel injection pumps to supply fuel to the cylinders of the engine in response to engine demand. The throttle control linkage (Fig. 1) includes bracket 61 having rack 62 adapted for cooperation with pawl 63 on throttle control lever 64. Control lever 64 is adjustable over a range to fix the engine speed from idling to full load, and is shown in Fig. 1 in its adjusted position determining full load operation of the engine, or in other words maximum engine speed. Lever 64 is pivoted on bracket 61 at 66, and has its lower end pivotally connected to link 67 which has its front end pivotally connected to one arm of lever 68 pivoted at 69 on bracket 70. The other arm of lever 68 is pivotally connected to adjustable rod 71 which extends forwardly, and is pivotally connected at 72 (Fig. 3) to adjustable connection 73 slidably mounted in bracket 74. Bracket 74 is mounted on engine block 12 exteriorly thereof; the control linkage extending

through bracket 74 and block 12 into timing gear housing 41. Cylindrical shield 76 is adjustably mounted on connection 73, and has telescopic engagement with bracket 74 to provide a seal between bracket 74 and connection 73. Shield 76 thus serves to prevent the entry of deleterious matter into the engine.

Adjustable stop means is provided to determine the maximum adjustment of the resilient governor means by the throttle control lever 64. The forward end of connection 73 (Fig. 3) is threaded at 77, and has adjusting nuts 78 threaded thereon adapted to contact face 79 of bracket 74, to determine the full load position of the throttle control means. Governor spring 80 is tensioned between connection 73 and arm 81 (Figs. 1 and 3) secured on shaft 82. Shaft 82 is suitably mounted in timing gear housing 41, and has arm 83 secured thereon. Arm 83 (Fig. 1) is pivotally connected to adjustable link 84 having its opposite end pivotally connected to arm 85 secured on sleeve 38. It will be recalled that sleeve 38 has upwardly extending arm 37 providing a connection to pump control bar 26.

From the foregoing description, it is seen that movement of throttle control lever 64 (Fig. 1) to the left places tension on spring 80 which (through arm 81, shaft 82, arm 83, link 84, arm 85 and arm 37) tends to move pump control bar 26 to the right, i. e., in the direction to cause increased injection of fuel. Such direction of movement is opposed by the centrifugal action of the governor fly balls as a result of increased engine speed caused by increased fuel injection.

Arm 81 (Fig. 1) is urged in counter-clockwise direction in response to increase of tension on spring 80 upon manual adjustment of the throttle control linkage to cause increased injection of fuel; and, as previously explained, such movement of arm 81 is opposed by the governor fly balls. For this purpose, arm 81 has integral lug 86 (Figs. 1 and 3) abutting an end of sleeve 87 slidably mounted on extension 88 of camshaft 89. Camshaft 89 is driven from the crankshaft through gear 90 having opposite pairs of projecting ears 91 providing a pivotal mounting for governor fly balls 92. Fly balls 92 have stop projections 93 adapted to engage gear 90 to limit outward movement of the balls, and have inwardly projecting ears 94 engaging sleeve 87 to impart movement thereto in accordance with movement of fly balls 92.

As seen in Fig. 3, rotation of gear 90 and camshaft 89 causes fly balls 92 to move outwardly whereby, through ears 94 on the fly balls 92, sleeve 87 is moved to the right. Such movement of sleeve 87 causes oscillation of arm 81 in a clockwise direction, as viewed in Fig. 1, opposing the force exerted thereon by spring 80. For any given setting of the throttle control lever 64 and the corresponding tension placed on governor spring 80, the centrifugal action of governor fly balls 92 produces a state of equilibrium in the throttle control linkage for the fuel pumps as long as the engine operates at a constant speed. As the speed of the engine increases or decreases in response to varying loads thereon, the centrifugal action of governor fly balls 92 in opposition to spring 80 causes corresponding oscillation of arm 81 to control movement of pump control bar 26; counter-clockwise oscillation of arm 81 increasing the fuel supply and clockwise oscillation thereof having the opposite effect. Thus, the engine speed is maintained substantially constant for any given load up to maximum.

Means are provided for automatic adjustment of the pump control bar 26 to cause an increase of fuel injection into the cylinders of the engine, when under full load setting of the throttle control linkage, the speed of the engine decreases in response to increase of load, or overload on the engine. Such increase in the amount of fuel injected effects an increase in torque whereby good lugging ability is provided in the engine.

Pump control bar 26 (Figs. 3 and 4), as previously described, is slidably mounted at its left end in bushing 27 having an annular flange held between housing 11 and plate 101 secured to said housing by suitable cap screws. The left end of bar 26 is threaded at 102 to receive castle nut 103 and lock nut 104, described more particularly hereinafter. Castle nut 103 (Fig. 4) is keyed on threaded portion 102 by L-shaped key 105 having one end disposed in slot 107 in threaded portion 102, and the other end in one of a plurality of evenly spaced slots 108 in castle nut 103. Leaf spring 111 is secured between plate 112 and block 113, to plate 101 by suitable cap screws. Dowel pin 114 mounted in plate 101 and engaging apertures in plate 112 and spring 111 determines accurate positioning of plate 112 and spring 111 with respect to each other, and with respect to bar 26.

Leaf spring 111 extends downwardly from between block 113 and plate 112, and has its lower end in the path of castle nut 103; the castle nut being in such position on bar 26 as to contact spring 111 when bar 26 is in position for full load engine operation. Plate 112 spaces spring 111 from face 115 of the plate 101, to provide for limited movement of bar 26 from its full load position, in response to the tension of spring 80 as the centrifugal force of the fly balls decreases. The entire assembly of the torque control spring 111 and the projecting end of the pump control bar 26 is enclosed by a cover 117 secured to plate 101 by suitable cap screws.

Spring 111 is precalibrated and the strength thereof is such that during normal operation of the engine with pump control bar 26 set at full load position (see Fig. 4) the spring serves merely as a resilient stop; the tension of spring 80 being counteracted by the centrifugal action of governor fly balls 92. However, when the speed of the engine decreases, because of overload on the engine, governor fly balls 92 move inwardly and the centrifugal action thereof is no longer sufficient to overcome the tension of spring 80 which acts to oscillate arm 81 in a counter-clockwise direction, thus moving bar 26 to the right against spring 111. The extent of movement permitted is determined by the thickness of plate 112.

It is seen, therefore, that spring 111 during normal engine operation serves as a resilient stop to determine full load operation of the engine, i. e., maximum normal fuel injection. Thus, the adjusted position of castle nut 103 and lock nut 104 on throttle slide bar 26 determines the maximum amount of fuel injected. However, should an overload be placed on the engine while operating at full load, spring 111 allows bar 26 to move to the right a slight amount to provide for increase in fuel injection, so as to impart great lugging ability to the engine.

In compression ignition and the like engines, it is important that the air-fuel ratio be maintained at the proper value, because the injection of more fuel than can be burned for a given air supply not only has a deleterious effect on engine performance, but also causes uneconomical oper-

ation. It is desirable, therefore, that the amount of fuel injected for full load operation be controlled in accordance with the amount of intake air at the altitude at which the engine is to operate. To accomplish this purpose, the construction and method of manufacture and assembly of the pump control means disclosed herein, provide a ready and facile adjustment to compensate for operation of the engine at varying altitudes.

Generally, the method is one of calibration and comprises initially setting the adjustable stop means **103** to determine metering of the correct amount of fuel for a given altitude. Thereafter, the pump control means is formed to provide an indication of such initial setting of the stop means. From such indication, other spaced indications are provided whereby accurate adjustment of the stop means to any desired position can be accomplished.

The altitude calibration is accomplished as follows: In assembly of the parts, slide bar **26** is held in a fixed position in housing **11**; the position being that which determines quantity of fuel injection for full load and full speed operating conditions of the engine at a given altitude, for example sea level. A spacer of the same thickness as plate **112** is then inserted between face **115** of plate **101** and spring **111** to preclude inward flexing of spring **111**. Nut **103** is screwed onto threaded portion **102** of slide bar **26** until its inner face just abuts spring **111**. Key **106** is slipped into slot **107** and into one of notches **108**, and an indication mark **121** is impressed on nut **103** opposite to the radial slot **108** in which the key engages. After this, lock nut **104** is screwed on threaded portion **102** and its outer end **122** is machined flush with the left end of slide bar **26**. Thus, whenever key **106** is in the marked slot **108**, and the ends of nut **104** and bar **26** are flush, the abutment stop which nut **103** provides is adjusted correctly for the given altitude. After the given altitude adjustment is obtained, the spacer previously inserted between spring **111** and face **115** is removed.

A chart is supplied to the user of the engine. Should such user intend to operate the engine at an altitude different from the given altitude, namely sea level, the chart will indicate to such user how many slots or notches **108** the nut **103** must be turned from its initial setting and the direction of turning of the nut, to provide for proper positioning thereof at the different altitude. Thus, the radial slots or notches **108** provide indicating means for determining adjustment of nut **103** for varying altitudes.

In the described construction, spring **111** is extremely desirable, inasmuch as it provides the resilient stop enabling increase of torque upon overloading of the engine while operating at full load and full speed capacity. It is apparent, however, that such spring can be omitted from the structure to enable nut **103** to abut against a fixed stop at full load, which fixed stop could be formed by face **115** of plate **101**, or by the left end wall of housing **11** if so desired. With spring **111** omitted, the other described advantageous features of my invention will, obviously, be unaffected.

Therefore, I claim as my invention:

1. In a fuel injection system for compression ignition and the like engines, a plurality of individually detachable fuel injection devices each having an element mounted for axial reciprocation to control operation thereof, the elements being all axially alined with adjacent ends of adjacent elements in surface to surface contact to provide for movement of all of said elements simultaneously in either direction and to allow for ready removal or insertion of any of said devices, and a C-clamp member mounted for reciprocation along an axis parallel to the axis of reciprocation of said elements and having spaced apart means engaging the outermost elements to effect simultaneous movement of all of said elements as a unit together in either direction, said clamp member comprising the sole means for maintaining said elements in free abutting relation.

2. In a fuel injection system for compression ignition and the like engines, a plurality of individually detachable fuel injection devices, each having an element mounted for axial reciprocation to control operation thereof, the elements being all axially alined with adjacent ends of adjacent elements in surface to surface contact to provide for movement of all of said elements simultaneously in either direction and to allow for ready removal or insertion of any of said devices, and a C-clamp member mounted for reciprocation along an axis parallel to the axis of reciprocation of said elements, said member having projections provided with surfaces spaced apart a distance substantially equal to the distance between the outer ends of the outermost elements and in surface to surface contact with such outer ends to effect simultaneous movement of said elements as a unit together in either direction, said clamp member comprising the sole means for maintaining said elements in free abutting relation.

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