Sept. 20, 1932. F. L. MORSE ET AL 1,878,796

AUTOMATIC DOOR

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Fig. 1

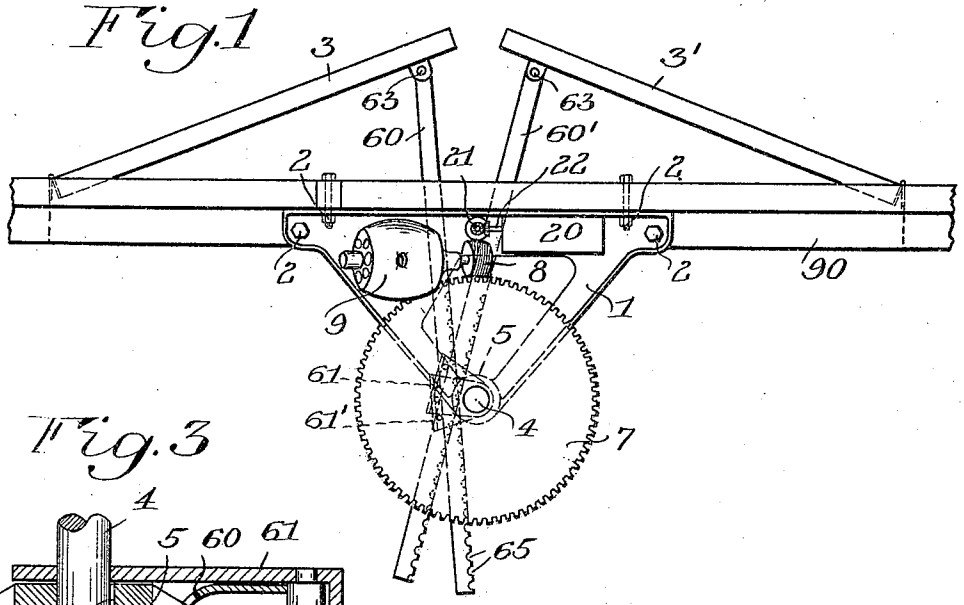


Fig. 3

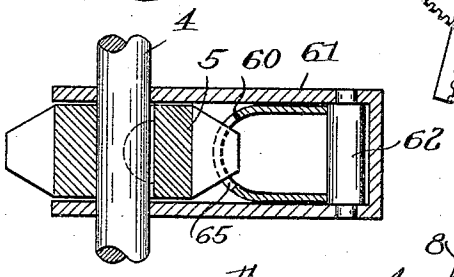
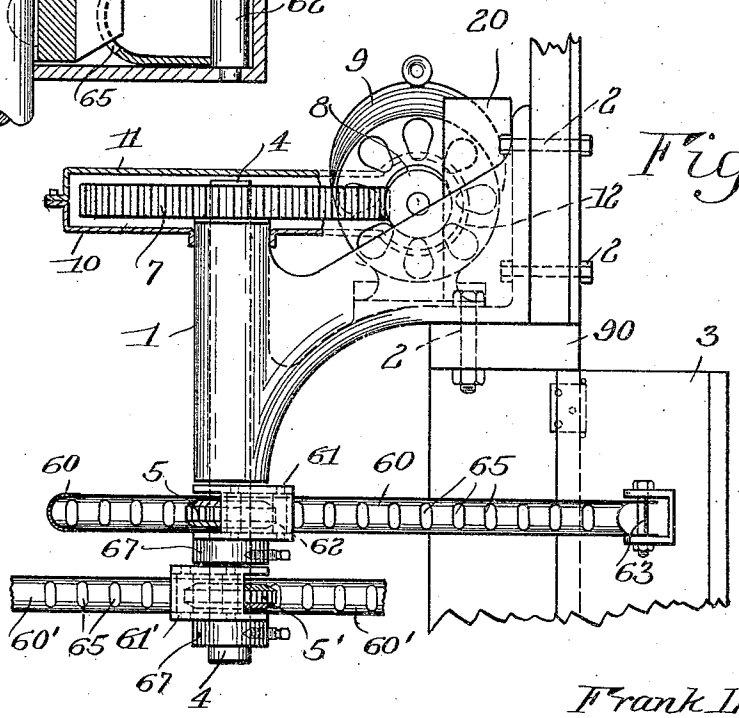


Fig. 2



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AUTOMATIC DOOR

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Fig. 4

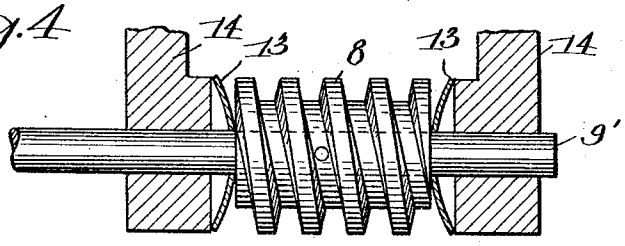
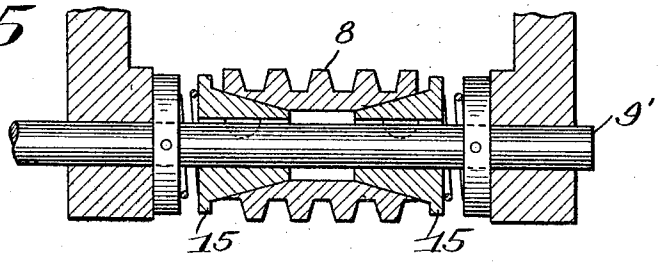


Fig. 5



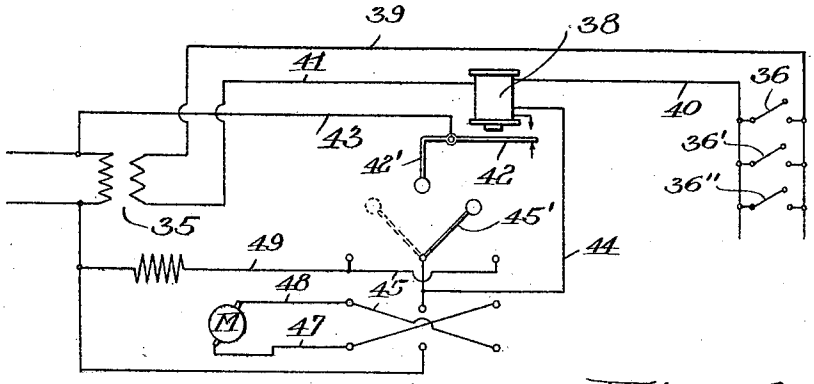


Fig. 6

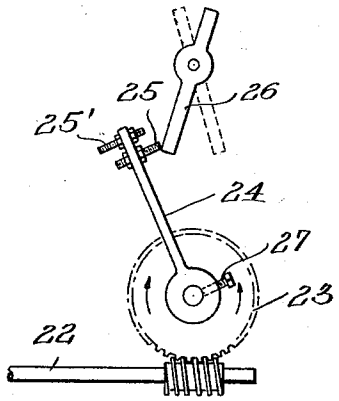


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Fig. 8

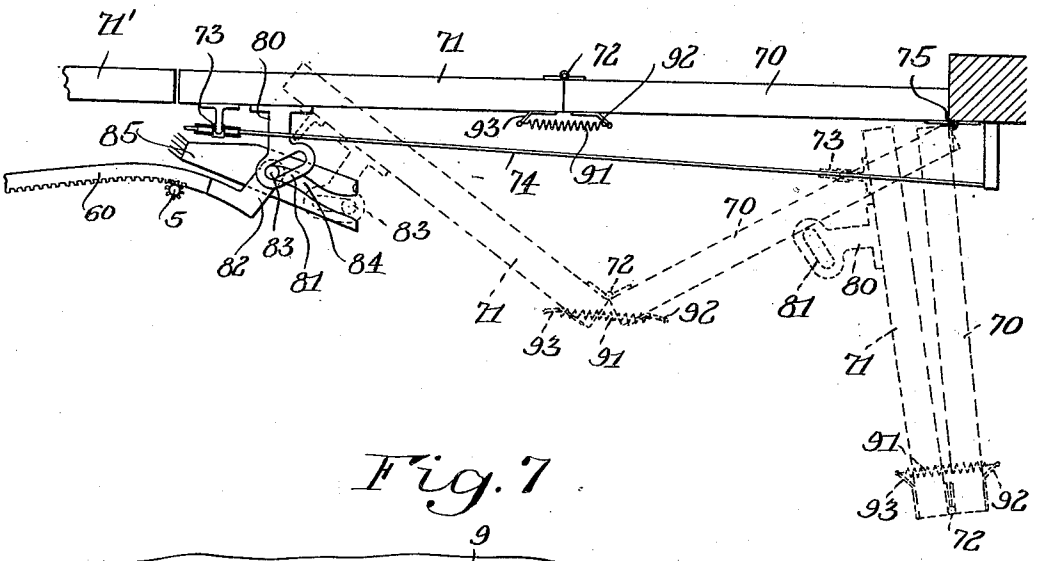
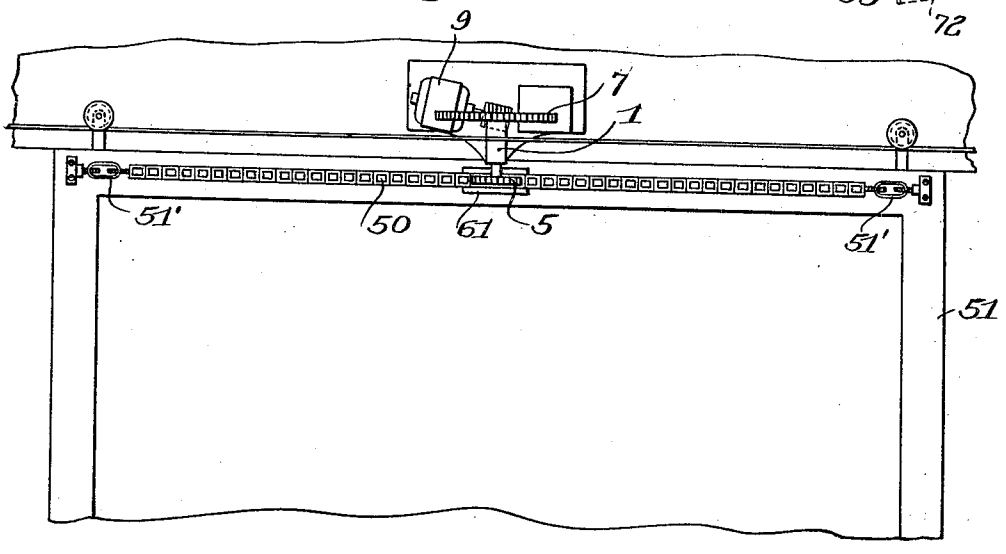


Fig. 7



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Patented Sept. 20, 1932

1,878,796

UNITED STATES PATENT OFFICE

FRANK L. MORSE AND ROBERT V. MORSE, OF ITHACA, NEW YORK

AUTOMATIC DOOR

Application filed December 22, 1927. Serial No. 241,835.

This invention relates to automatic mechanisms for operating garage doors or the like where it is desired to utilize a distant control. Many mechanisms have been proposed for operating garage doors automatically, but they have been in general either expensive, or difficult to ship as a commercial product and install in the average garage, or else have not been universally applicable to the different types of doors found on various garages. The primary object of this invention is to produce a simple and practical device which will overcome some of the foregoing difficulties. In particular it is desired to produce a mechanism which can be readily manufactured and shipped, can be installed in the average garage with a minimum of expense, and one which to a considerable extent can use the same parts on various types of doors, thus opening up a more universal market and permitting more efficient production. Another object of the invention is to apply the power more effectively to the door, particularly with a view to operating the door with less strain on the door structure and hinges, inasmuch as the doors and hinges of the average garage are not adapted to withstand heavy mechanical stresses. Other objects will become apparent as the description proceeds.

Referring now to the drawings,—Fig. 1 is a plan view of the operating mechanism as applied to outward swinging doors. Fig. 2 is a side elevation of the operating mechanism of Fig. 1. Fig. 3 is a detail cross-section of one of the guides and operating rods. Fig. 4 is a cross-section of one form of worm drive. Fig. 5 is a similar cross-section of a modified form. Fig. 6 is a diagram of the electric wiring and control mechanism. Fig. 7 illustrates the mechanism as applied to sliding or rolling doors. Fig. 8 illustrates the application to folding doors.

Referring first to Fig. 1 and Fig. 2, the motor mechanism which delivers the power to the rods that operate the doors is shown mounted in a frame or bracket 1. This is adapted to be bolted either on or above the lintel 90 of the doorway by suitable lag screws or bolts in the holes 2, 2,—these holes 2, 2, being provided at various points on the bracket 1 so that it can be secured to the nearest convenient surface with a minimum of labor and without requiring re-drilling. When a pair of doors 3, 3′, are used, such as illustrated in Fig. 1 and Fig. 2, the bracket or frame 1 is generally bolted to the lintel 90 above the middle of the door opening.

Mounted in suitable bearings in the bracket 1 is a vertical shaft 4 having on its lower end the pinion or pinions 5, 5′, which operate the door actuating mechanism described later. On the upper part of the shaft 4 is keyed a worm which is driven by the worm 8 on the shaft 9′ of the electric motor 9. Any other type of reduction gearing between the motor 9 and the shaft 4 may of course be used, but in the preferred form here illustrated a worm type of reduction gearing is employed and enclosed in an oil tight case 10 having a cover 11 shown in section in Fig. 2 to permit ample lubrication without undue waste or dripping. This case 11 is provided with a cup or depression 12 below the worm 8, so that any oil thrown off the wheel 7 will drain to the depression 12 and again lubricate the worm 8, while any oil that escapes toward the center of the worm wheel 7 will lubricate the vertical shaft 4.

In order to facilitate the manufacture of the worm wheels 7 in quantity, and to obviate the necessity of hobbing each worm wheel separately, the teeth of the worm wheel 7 may be cut straight sided and parallel to the axis of the shaft 4, and the motor mounted on an inclined seat on the bracket 1, so that the shaft and axis of the worm 8 are tilted at an angle as shown in Figs. 1 and 2, in order to provide the necessary lead. This permits the worm wheels 7,—which are the relatively expensive part,—to be stacked and cut like ordinary spur gears, a considerable number at a time.

The momentum of a high speed electric motor in stopping is liable to cause excessive stresses in the gearing when the doors are suddenly brought to a stop as in closing, particularly if there happens to be some slight error in the adjustment of the cut-off switch. To prevent such excessive forces there is pro-

vided a combined end thrust cushion and friction brake 13 on the motor shaft, operating on the thrust faces of the worm 8, as shown in Fig. 4. In the simple form shown in Fig. 4 this consists of dished thrust washers 13 having a certain amount of spring, interposed between the thrust faces of the worm 8 and the fixed abutments 14. Under ordinary conditions the thrust is taken by the central part of the washer, where the radius and friction are least; but under excessive thrust the washer will flatten out, and there will be frictional contact over substantially the entire surface out to the rim, thus bringing the worm quickly to a stop. More elaborate equivalent forms may of course be used, with the spring part separate from the brake parts. In another preferred form as shown in Fig. 5, the worm 8 is not keyed to the motor shaft 9', but is driven by a friction clutch 15, which can slip under excessive load. By so locating the slipping clutch the doors are positively held and locked, just as though the worm were keyed to the motor shaft, whereas if the clutch were located say between the worm wheel 7 and vertical shaft 4, the doors could be pulled open against it.

The motor 9 is of the reversible type, and may be controlled by any suitable remote control or switch system adapted to start and stop the motor and reverse it at each end of the travel of the doors, or at the end of a certain number of revolutions of the motor.

In the form illustrated in Fig. 1, Fig. 2, and Fig. 6, the switch system is mounted in a box 20 on the bracket 1, and is connected to the worm 8 thru a reduction gearing 21 and shaft 22 which operates the switch mechanism as shown more in detail in Fig. 6. The shaft 22 operates a worm gearing 23 which turns an arm 24 thru an arc as the doors go thru their travel,—the switch trigger 26 being thrown for example substantially in the position shown in solid lines when the doors approach fully open, and in the dotted line position when they approach fully closed, being operated by the arm 24 swinging backward thru almost a complete revolution during the travel of the doors. The arm 24 carries two contact pins 25 and 25', threaded for fine adjustment, which operate the switch trigger 26,—one of the pins operating for closing and the other for opening. The coarse adjustment is obtained by setting the arm 24 relative to the worm gear 23 by loosening the set-screw 27. When the trigger 26 is thrown from one position to the other the motor 9 is stopped, as will be described, and connections are changed which will result in the motor 9 running in the opposite direction when it is again started. The gearing just described times or counts the revolutions of the motor between operations of the switch.

One illustrative form of switch wiring adapted to be operated by the trigger 26 as above described is shown diagrammatically in Fig. 6. In the preferred form this is of the low voltage or relay type,—that is, the operating buttons or switches directly used by the operator of the car are on a low voltage circuit which controls the higher voltage switches in the box 20,—so that the actual motor current does not flow thru the external operating switches. Referring now to Fig. 6, the line current passes thru the transformer 35 thus reducing the voltage for the use of the external control switches 36, 36', 36'', etc., which are located at various points convenient for operation. Any suitable type of control switch may be used, either operable manually or by the weight or contact of the car itself going into or out of the garage, and the particular structure of these switches is immaterial to the present invention. These switches 36, 36', etc., are arranged in parallel, so that any one of them will close the secondary circuit, which includes the energizing coil of the relay switch 38. The low voltage circuit is therefore from the transformer 35, wire 39, any one of the switches 36, 36', 36'', wire 40, energizing coil of the relay switch 38, and wire 41 back to the transformer 35.

When any one of the switches 36, 36', etc., is closed, the relay 38 is actuated, closing a switch 42 which is in the primary or line-voltage motor circuit. This motor circuit may be traced from the line thru the conductor 43 to the relay switch 38–42, then around the energizing coil of the relay switch 38,—this coil being separate from the low voltage coil described, but arranged so either or both coils can operate the relay switch 38–42. The circuit passes thru the conductor 44 to the reversing and circuit breaking switch 45 which is operated by the trigger 26 before mentioned. This switch 45 has two positions, and is of the quick-break type,—that is, the gradual action of the trigger 26 stores up energy,—usually in an intermediate spring, until at a certain position the switch 45 snaps from one position to the other, as is common practice with switches of 110 volts or higher. In one position of the switch 45 the circuit is thru the motor armature M and conductors 47 and 48 in one direction; and in the other position of the switch 45 the motor circuit is reversed, and passes thru the conductors 48, 47 and armature M in the opposite direction. The field circuit of the motor M thru the conductor 49 is not reversed, though it is momentarily broken, like the circuit thru the armature M, when the switch 45 is being thrown from one position to the other.

The general operation is as follows:—when any one of the switches 36, 36', etc., is closed the relay switch 38–42 is energized thru its low voltage coil and closes the switch 42 in

the power circuit. Inasmuch as the switch 45 is already closed in one or the other of its positions the high voltage current immediately flows thru the motor circuit and also thru the energizing coil of the relay 38, thus holding the switch 42 closed even after the switch 36, 36', etc. is opened. This is desirable as the switches 36, 36', 36'', etc., are usually of the momentary contact self-releasing type and are not held closed by the operatior for any great length of time.

The motor M continues to run and the switch 42 continues closed, until when the door approaches the end of its travel, the trigger 26 is operated as has been described, and the snap action of the switch 45 throws it to the other position. When the switch 45 is moving to its new position both the armature and the field circuits of the motor are momentarily broken, thus interrupting all current flow in the relay 38, and opening the switch 42. In order to have positive assurance that the switch 42 will open when the switch 45 is being thrown, an arm or cam 45' is attached to the switch 45 and a cooperating arm or cam follower 42' is attached to the switch 42, and arranged so that the arm 45' will strike the arm 42' when the switch 45 is swinging thru its middle position and will knock the swtch 42 open. When the switch 45 closes in its new position the circuit is open at the switch 42, and the motor M will stop. In order to start the motor M again one of the switches 36, 36', etc., must be closed to initially energize the relay 38,—in which case the motor M will run in the opposite direction, owing to the reversal of the switch connections 45.

From the operator's standpoint, pressing a button opens the doors, which automatically stop when fully open; and another press of the button closes the doors automatically. In the foregoing the operator's switches have been described as in a low voltage circuit, as is usually desirable, but of course the operator's switches may be directly connected to the line voltage if desired.

If the door structure to be operated is of a very simple form, such as a straight door sliding or rolling sideways on a track, no further mechanism is necessary for its operation, beyond a simple chain 50 attached to the door 51, as shown in Fig. 7, and arranged to mesh with the pinion or sprocket 5 which is turned by the motor mechanism. The ends of the chain 50 are adjustably attached to the door 51' by means of turnbuckles 51', so that the precise location of the chain 50 can be adjusted after the door machine 1 is mounted in place, permitting an accurate running adjustment between the stop mechanism and the door. A similar mechanism may be used with the overhead or rolling type of door, a chain being preferably employed. In such cases the mechanism merely has to handle a straight pull for a certain distance, back and forth, and the bracket 1 with its motor and gear mechanism can be located at any convenient point along the line of pull.

The cases of outward swinging doors, inward swinging doors, and jack-knife or folding doors present greater difficulty, especially as in the latter case varying angular relations must be considered. In such cases the bracket 1 is usually mounted over the center of the door, bringing the mechanism fairly close to the front of the garage, and avoiding the special beams and supports required by mechanisms placed further back. If there are a pair of doors, as is usually the case, the pinion 5 is made double width, or in the form of a double pinion 5, 5', so as to accommodate a pair of door operating rods 60 and 60', which mesh with the pinions 5, 5', and are held in contact therewith by the swivel guides 61 and 61' as shown in Figs. 1, 2, and 3. These guides 61 and 61' are substantially triangular in form, having guide rollers 62 at two corners to prevent the rods 60, 60' from binding therein, and being pivoted at the third corner around the vertical drive shaft 4, so that they will swing freely to whatever angle the door operating rods 60, 60', assume, while always maintaining the rods in mesh with the pinions 5, 5'.

These door operating rods 60, 60', are supported in the guides 61, 61', and also supported by being attached at one end to the doors 3, 3' by the pins 63, as shown in Fig. 1 and Fig. 2. With automatic swinging doors the pins 63 are located close to the free edge of the door, so as to hold the doors with a maximum rigidity, and to allow a maximum travel of the rods 60, 60',—in order to most effectively employ the motor 9. When the doors are closed, the free ends of the door rods 60, 60' overhang in space, as the two centers of support are then relatively close together. Under such conditions the unsupported portion of the door rods is longer than the portion supported between the guides 61, and pin 63, though if the rods are very heavy additional supports may be used. In order that the door operating rods may be light, strong, rigid, and easy to manufacture, the construction shown in Fig. 2 and Fig. 3 may be used, in which the rod 60 is made of a strip of metal bent into the form of a U channel, with holes 65 punched at intervals to mesh with the teeth of the pinion 5. The ends of the U, forming the straight edges of the back of the door operating rod 60, bear against the rollers 62 of the guides 61. In some installations, particularly with inward folding doors, the rods 60 may be curved or arcuate in the direction of their length as in Fig. 8, instead of being straight,—thus preventing interference with parts of the doors or other structures during the operation of the doors. It will be understood that the

term rods is used herein in a general sense to include both the straight and the curved variety.

The weight of the guides 61, 61′ and rods 60, 60′ is carried on thrust collars 67, 67′, secured to the vertical drive shaft 4, which takes the vertical thrust load on the under side of the worm wheel 7 or other suitable thrust bearing carried by the shaft 4.

With outward swinging double doors 3, 3′, the rods 60, 60′ pass on the same side of the pinions 5, 5′, as shown in Fig. 1, so that the rods move in general in the same direction. In the case of inward swinging doors, and jack-knife or folding doors, which will now be described, the rods 60, 60′ pass in general on opposite sides of the pinions 5, 5′ so as to be moved in opposite directions.

With jack-knife or folding doors, such as shown in Fig. 8, there are two distinct motions to be contended with, if a smooth and reliable action applicable generally to such doors is to be produced. These doors are in sections, 70, 71, each pair of sections hinged together as at 72, and supported by rollers 73 which run on a track 74 overhead. In Fig. 8 only one pair of these sections is shown for the sake of clearness, but it will be understood that there is generally another similar pair 71′ and its mate on the other side of the pinion 5,—in other words, only half of the door opening is shown. The track 74 is usually substantially straight, though it may be curved at the end near the main hinges 75 of the door. As the doors 70, 71, lie in a straight line when closed, it is first necessary to "break" them, or to bend them into a V shape on the hinges 72, before a longitudinal force along the general direction of the track, or in the direction of the main hinges 75, will suffice to force the doors along to a full open position.

To accomplish this motion of first "breaking" the doors, and then rolling them along their track, the operating rod 60 is connected to the second or central leaf of the door 71 by means of a bracket 80 having a roller cam slot or slots 81. The rod 60 is provided with a fork 82 carrying a cam roller 83 adapted to move in the slot 81 and also by means of the same or corresponding rollers to move in the fixed cam slot 84, which may be in a bracket 85 or other fixed element secured to the garage structure or to the bracket 1 of Fig. 2. While in the preferred form the fixed cam surfaces are shown in the form of a slot 84, it will be understood that any other nearby surfaces having the same general direction may be utilized,—for example, by using a larger roller 83 the side of the track 74 or the lintel of the door may be used as cam surfaces on which to roll the cam roller 83.

The bracket 80 containing the slot or slots 81, is bolted to the door 71, and either the bracket 80 or the bracket 85 is preferably made in a bifurcated form so as to straddle the cam roller 83 and balance the twisting forces,—though the cam mechanism can also be made with single slots provided the bearing faces are long and well supported.

In the operation of the folding doors, starting from the closed position, the roller 83 attached to the rod 60 is then at the end of the slot 81 nearest the driving pinion 5 of the door operating machine. The initial motion of the rod 60 tends to push the cam roller 83 along the slots 81 and 84, exerting a force upward (in Fig. 8) on the slot 84, downward on the slot 81, and forcing the door 71 to rotate inward around the pivot of the supporting trolley 73. The next effect is to exert a thrust on the side of the slot 81 away from the doors, which tends to cause the doors 70, 71 to "break" at the middle along the line of the hinges 72, assume a V shape as indicated in dotted lines, and carry the line of thrust of the rod 60 to the inside of the line of the main hinges 75, after which the continued motion of the rod 60 and roller 84 pressing against the other end of the slot 81 carries the doors on to their fully open position, as shown in full lines at the right of Fig. 8.

In closing the pull of the rod 60 first causes the roller 83 to seek the end of the slot 81 nearest to the pinion gear 5, and then draws the doors along to their closed position. As they approach the closed position the roller 83 enters the cam slot 84, which forces the doors smoothly to a fully closed position. The paths of the roller 83 opening and closing cross at a certain point, and the mouth of the cam slot 84 may be located there to receive the roller. It is sometimes desirable to protect the doors against undue toggle action or bending under wind stresses when closed, as well as to make them open fully, and a spring 91 may be mounted between brackets 92 and 93 attached to and extending above the tops of the doors 70, 71 respectively. The dead center of the action of the spring 91 occurs when the doors 70, 71 are in the V position partly open; and once past that position the spring 91 will tend to carry the doors on to the fully open or fully closed positions,—and will thus serve to hold the doors against bending when closed. The end of the slot 84 may also be made parallel to the lintel for a short distance, which will serve to substantially lock the door when closed.

In the foregoing there have been described various illustrative forms of the invention, but it will be understood that these are merely by way of example, and that the invention is susceptible to various modifications and adaptations in various installations without departing from the scope of the invention as defined by the following claims.

1. In a door operating mechanism, the combination of an electric motor, means for controlling said motor, a reduction gearing driven by said motor, a plurality of doors, a vertical drive shaft driven by said reduction gearing, a pair of actuating rods operatively connected to the doors at points more than half way out from the sides of the doorway, gear teeth attached to the vertical drive shaft, guides adapted to retain the actuating rods in mesh with said gear teeth, the rods being arranged so that when the doors are closed the rods will cross each other as viewed from above and the greater part of their length will overhang in a direction away from the doors.

2. In a door operating mechanism, the combination of an electric motor, means for controlling said motor, a reduction gearing driven by said motor, a plurality of doors, a vertical drive shaft driven by said reduction gearing, a pair of actuating rods operatively connected to the doors, gear teeth attached to the vertical drive shaft, guides adapted to retain the actuating rods in mesh with said gear teeth, the rods being arranged so that when the doors are closed the rods will cross each other as viewed from above and will extend beyond the drive shaft for the greater part of their length in a direction away from the doors.

3. In a door operating mechanism, the combination of a drive shaft having teeth attached thereto, means for operating said shaft, a plurality of doors, a pair of actuating rods operatively connected to the doors and meshing with the teeth on the drive shaft, said rods being curved in the plane of their motion and being arranged so that they will cross each other as viewed from above when the doors are closed.

4. In a door operating mechanism, the combination of a plurality of doors in a doorway, a vertical drive shaft located near the middle of said doorway, means for driving said shaft, gear teeth attached to said shaft, actuating rods operatively attached to the doors and partially supported by their attachment thereto and adapted to mesh with the gear teeth, said rods being crossed as viewed from above when the doors are closed, guides adapted to retain the actuating rods in mesh with the gear teeth and aid the door attachment in supporting the weight of the rods, and a thrust bearing collar on the shaft below the guides.

5. In a door operating mechanism, the combination of a track, a pair of doors hinged together and mounted to fold on each other, means supporting one of said doors on the track, said supporting means being adapted to roll along said track as the doors fold, a bracket attached to the door supported by said rolling means, said bracket having a slot inclined in a direction that approaches said door at the same time it approaches the hinge, and operating means adapted to travel in said slot to approach said hinge as the doors are folded open and to travel away from said hinge toward the free end of the doors when the action is reversed to start closing the doors, whereby the returning force is applied nearer the track at the beginning of the closing operation than the opening force was at the end of the opening operation.

In witness whereof we have hereunto set our hands this 19th day of December, 1927.

FRANK L. MORSE.
ROBERT V. MORSE.