

Jan. 9, 1951

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2,537,185

PNEUMATICALLY OPERATED SIGNAL TRIP MECHANISM

Original Filed Dec. 16, 1941

4 Sheets-Sheet 1

FIG. 1

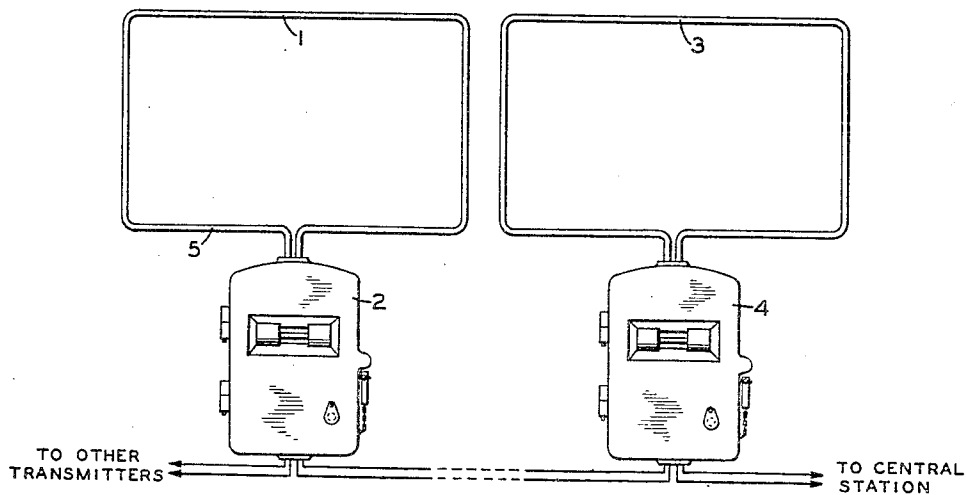
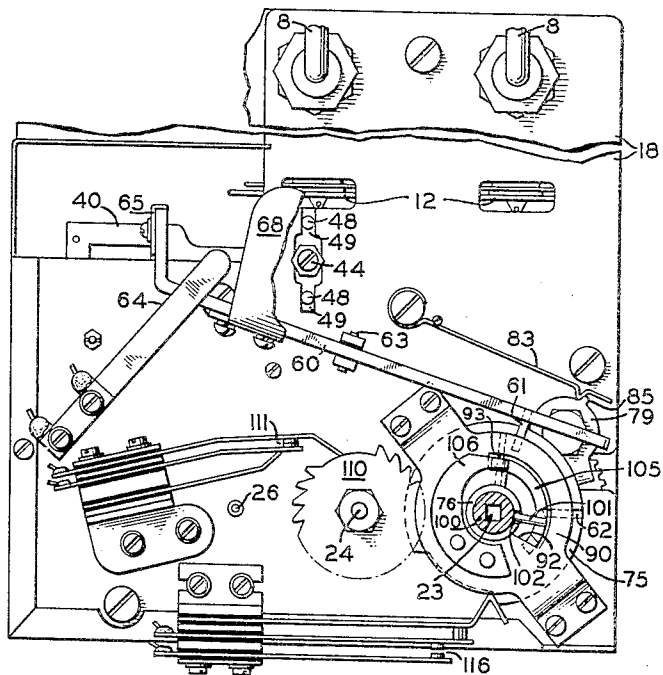


FIG. 2



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4 Sheets-Sheet 2

FIG. 3

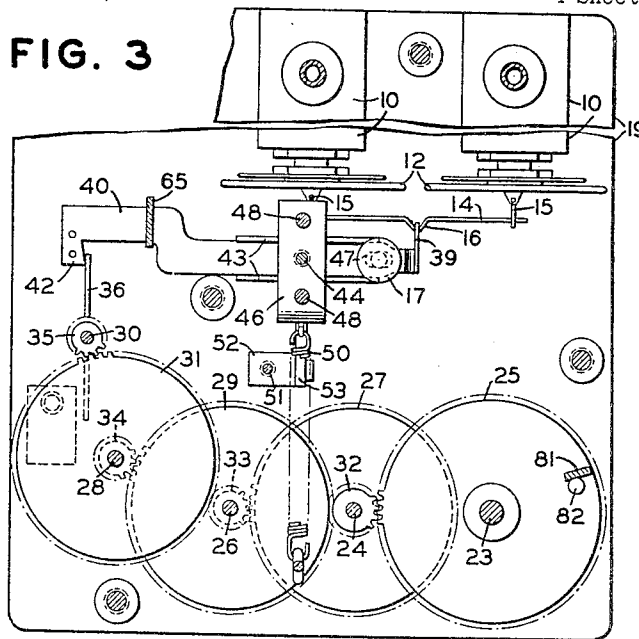


FIG. 5

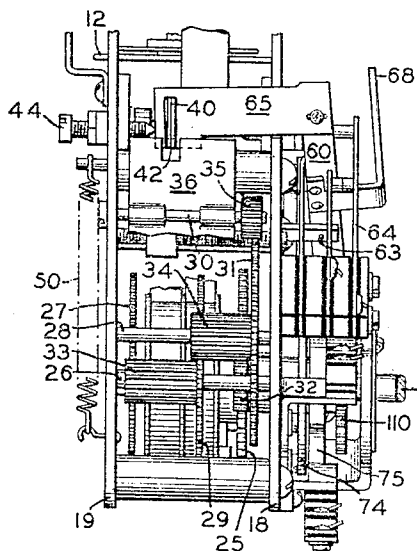
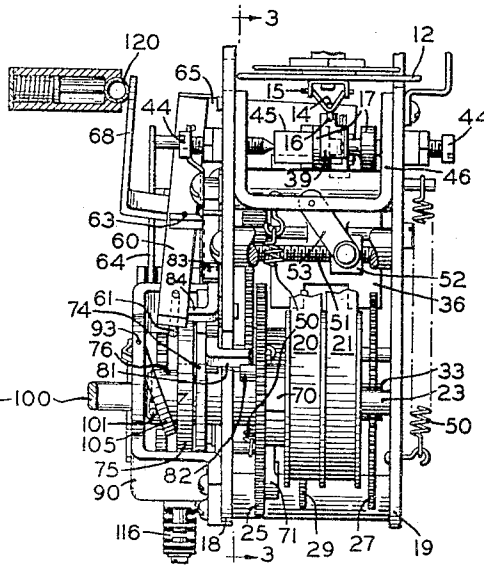


FIG. 4



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4 Sheets-Sheet 3

FIG. 6.

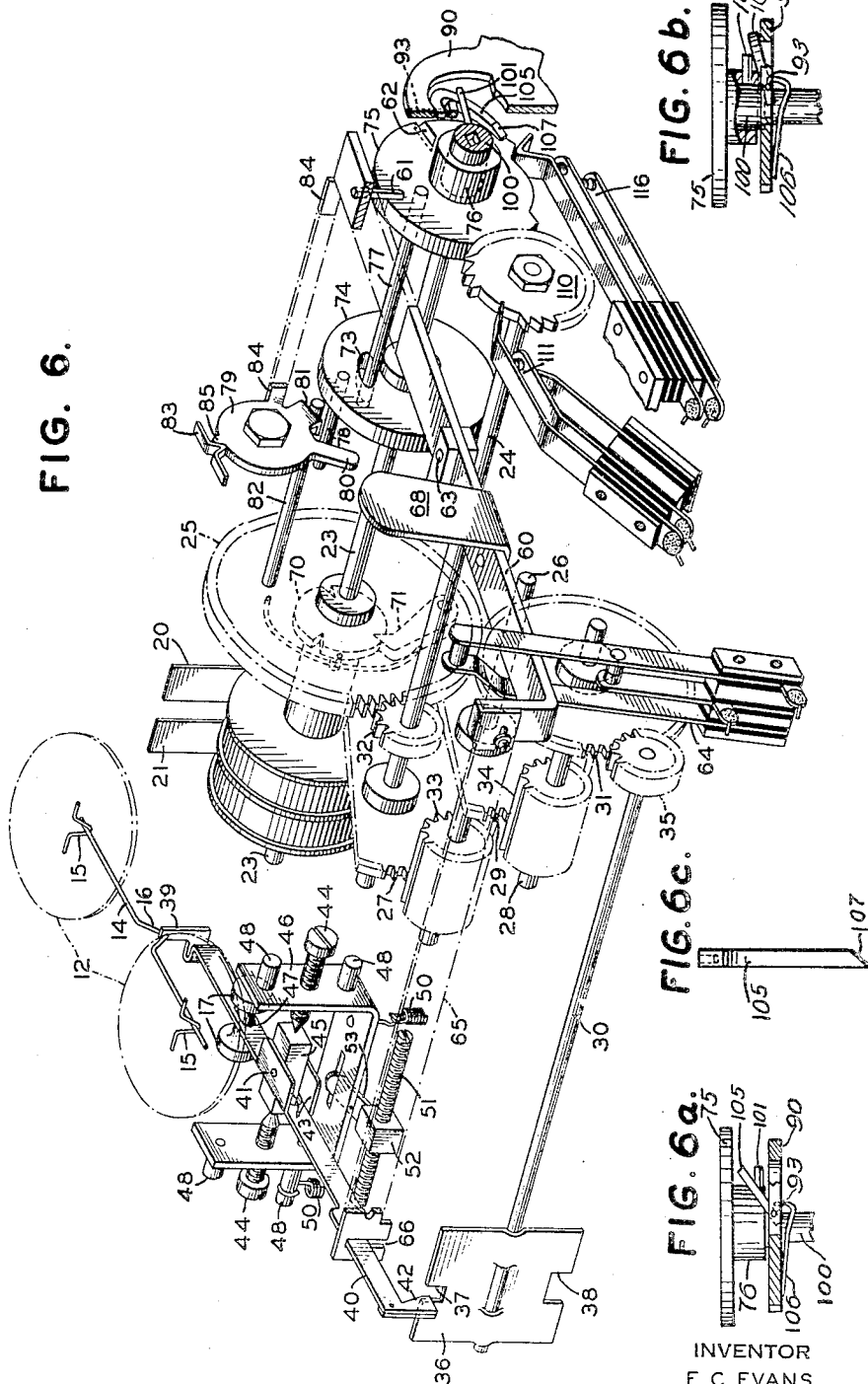


FIG. 6b.

FIG. 6c.

FIG. 6a.

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4 Sheets-Sheet 4

FIG. 7

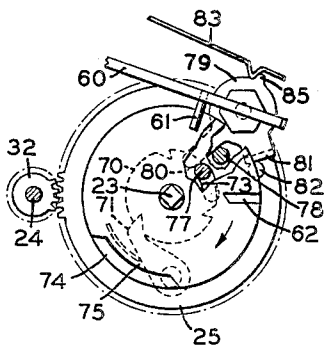


FIG. 8

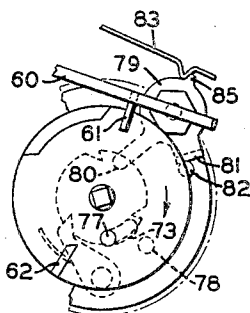


FIG. 9

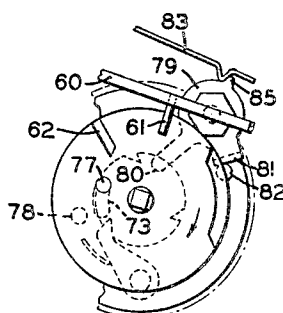


FIG. 10

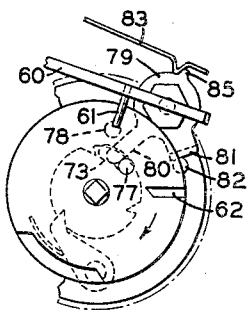


FIG. 11

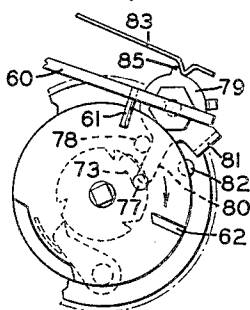


FIG. 12

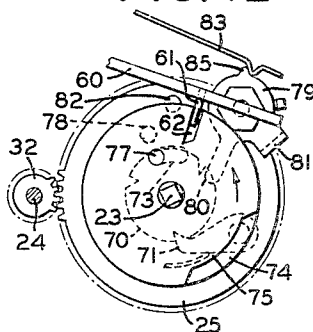


FIG. 13

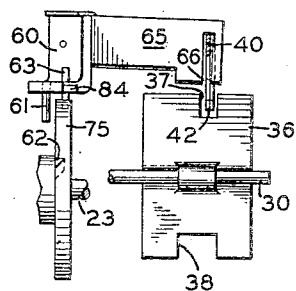
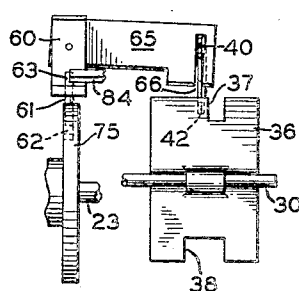


FIG. 14



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UNITED STATES PATENT OFFICE

2,537,185

PNEUMATICALLY OPERATED SIGNAL TRIP
MECHANISM

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Original application December 16, 1941, Serial No.
423,130, now Patent No. 2,410,814, dated No-
vember 12, 1947. Divided and this application
August 31, 1946, Serial No. 694,385

9 Claims. (Cl. 74—2)

1

This invention relates generally to signaling systems and more particularly to aero tube alarm systems for detecting dangerous rises of temperature and initiating an alarm signal in response thereto.

This application is a division of my copending application Serial No. 423,130, filed December 16, 1941, for "Signaling System," Patent No. 2,410,814, issued November 12, 1947.

Aero tube alarm systems consist of one or more lengths of aero tubing extending through and about an enclosure which it is desired to protect and in such relation to the enclosure that dangerous temperatures can be detected within a minimum time. The tubing may contain a gas either under, at or in excess of atmospheric pressure, which gas expands in response to increases of temperature to thereby increase the pressure within the system. In accordance with conventional practice each end of the tubing circuit is connected to an expansion chamber consisting of a pair of flexible diaphragms for converting changes of pressure within the tubing system into mechanical motion which may be utilized to operate electrical contacts. The tubing system may be operated to respond to a predetermined temperature or a predetermined rate of rise of temperature, the latter characteristic being obtained by the provision of a vent adjacent each expansion chamber for compensating pressure changes occurring at a rate below fixed limits whereby normal temperature changes do not result in the initiation of an alarm. If, however, a dangerous rate of change of temperature occurs, the expansion of the gas within the tubing system occurs at such a high rate that the pressure within the expansion chamber exceeds the limiting pressure to thereby initiate an alarm.

It has been the practice to operate electrical contacts by means of the pressure responsive diaphragms to thereby change the characteristics of an electrical circuit and in turn initiate operation of a signal transmitter by means of an electro-mechanically operated trip mechanism. The trip mechanism releases an electrical signal transmitting device to cause transmission of code signal impulses from the transmitter located in the protected premises over a transmission line to a central station to thereby summon assistance. The use of electrical circuits including contacts and electro-mechanical devices in the protected premises necessitates the use of local battery sources of electrical energy, thereby increasing the expense of installation and the

2

amount of investment required in the alarm system.

The alarm signal transmitter, which is electrically tripped, is usually driven by a spring motor which requires manual winding after each alarm transmitting operation, and it is necessary that the condition of the spring driven motor be known to the central station attendant. Therefore, such transmitters are adapted to transmit a restoration signal after each winding operation which signal indicates to the central station attendant that the transmitter has been wound and is in condition to respond to the fire detecting system and transmit an alarm signal. It is necessary, however, to insure that the transmitter is wound to such an extent that the restoration signal will be automatically transmitted as it frequently happens that unskilled persons reset and wind the transmitter, and it is further necessary that such transmitters be provided with mechanism for preventing a saboteur or incendiary from blocking the action of a transmitter to thereby accomplish his purpose without the initiation of a fire alarm.

The principal object of this invention is to provide a signal transmitter which may be directly and mechanically operated by and in response to small temperature-induced pressure variations in an aero tube system.

A further object of this invention is to provide a mechanically tripped signal transmitter for use in aero tube fire alarm systems which is sensitive to low pressure variations in such systems and at the same time resistant to the effects of vibration.

A further object of this invention is to provide a mechanical trip mechanism in a signal transmitter which is responsive to pressure changes within an aero tube circuit in a positive and fool-proof manner.

A still further object of this invention is to provide an aero tube fire alarm system including a mechanically tripped signal transmitter, the system having uniform sensitivity to temperature changes of a predetermined rate of rise throughout its entire length.

Still another object of this invention is to provide an aero tube system which may include pressure detecting diaphragms having non-similar characteristics, together with a means for obtaining uniform operation and sensitivity throughout the system in spite of the said non-uniform characteristics.

Further objects and advantages of this system will be apparent after consideration of the

following specification and the accompanying drawings wherein:

Fig. 1 diagrammatically illustrates two aero tube fire detecting systems, together with signal transmitters;

Fig. 2 is a front elevation of the signal transmitter embodying this invention;

Fig. 3 is a front of Fig. 2 with the front plate removed;

Fig. 4 is a view from the right side of Fig. 2;

Fig. 5 is a view from the left side of Fig. 2;

Fig. 6 is an expanded perspective of the transmitter with supporting structure omitted;

Figs. 6a, 6b, and 6c are fragmentary views of a portion of the key winding mechanism shown in Fig. 6;

Fig. 7 illustrates the spring motor trip mechanism in its rundown condition;

Fig. 8 illustrates the spring motor trip mechanism after 120 degrees of rotation during the winding operation;

Fig. 9 illustrates the spring motor trip mechanism after 240 degrees of rotation during the winding operation;

Fig. 10 illustrates the spring motor trip mechanism after 360 degrees of rotation during the winding operation;

Fig. 11 illustrates the spring motor trip mechanism at the start of transmission of the restoration signal;

Fig. 12 shows the spring motor trip mechanism in condition to transmit an alarm signal;

Fig. 13 illustrates the diaphragm operated trip mechanism in the running condition; and

Fig. 14 illustrates the diaphragm operated trip mechanism in a position preparatory to transmission of an alarm signal.

Fig. 1 of the drawings illustrates a pair of separate aero tube circuits 1 and 3, each of which may individually be located within separate enclosures such as one or more rooms in separate buildings or groups of rooms in the same building, for the purpose of detecting dangerous rises of temperature therein. Each of the circuits 1 and 3 is connected to the transmitters 2 and 4, respectively, these transmitters being connected as shown in Fig. 1 in a loop circuit which terminates at a central station where annunciators, recorders and alarm devices are arranged to be responsive to transmitted signals. Fig. 1 is an illustration by way of example only, it being intended that the system shall include whatever number of aero tube circuits and transmitters may be necessary and feasible in a particular installation.

The tubing circuits terminate at each transmitter in detector units such as are partially shown in Figs. 2 and 3 of the drawings, and which may be constructed in accordance with the specification and drawings of the patent to F. M. Cowan, No. 2,100,184, of November 23, 1937. Fig. 2 of the drawings shows tubing 3 entering the detector unit designated in general by numeral 10, this unit containing passages from each end of the tubing to the diaphragm expansion devices 12. Diaphragms 12 are connected together, as shown in Fig. 3 to act either separately or in unison by means of the arm 14 and links 15 so that the operative function of the aero tube system as a whole occurs at the midpoint of arm 14 which is the V-shaped portion 16. This overcomes the characteristic of non-uniform response in aero tube systems which is caused by different degrees of response, depending upon the proximity of a fire condition

to one or the other of the diaphragms 12 at the ends of the tube. Thus, the degree of displacement varies in accordance with the proximity of the fire to each diaphragm. However, it will be seen that the degree of movement at the point 16 on arm 14 will be the same regardless of the degree of movement of each of the diaphragms 12. For instance, a fire in the vicinity of the point 5 in tubing circuit 1 will expand the air within the tubing and cause deflection of diaphragm 12 connected to the near end of the tubing circuit but will cause very slight, if any, deflection of the diaphragm connected to the other end of the tubing circuit. Therefore, one end of the arm 14 will be lowered about the other end of the arm as the pivot point, the point 16 moving one-half the distance through which the actuated end can move. Thus, a fire at either end of the tubing circuit causes a deflection at point 16 equal to one-half the deflection of the actuated diaphragm. If a fire occurs at a point equidistant from the ends of the loop, both of the diaphragms 12 are deflected only one-half as much as each of them would be if the fire was located close thereto, but both of the diaphragms are deflected to thereby cause the point 16 of arm 14 to move through the same distance as it does when only one diaphragm is deflected.

This characteristic of the system constructed in accordance with this invention eliminates the necessity for adjusting a trip element or contact elements for any particular maximum or minimum degree of movement of the diaphragms for the reason that regardless of the location of the fire with respect to the ends of the loop circuit the point 16 of arm 14 always travels through the same distance. Furthermore, this feature of the invention averages whatever differences there may be in the characteristics of different diaphragms so that the aero tube circuit is uniformly sensitive throughout its length and the motion of the point 16 of arm 14 is approximately the same regardless of slight variations in the degree of deflection of said different diaphragms under the same pressure conditions.

The effects of vibration on the tripping mechanism are eliminated by the provision of weight 17 in slot 47 of lever 40. The weight 17 is adjustable horizontally in slot 47 to vary the downward tension on diaphragms 12 to thereby adjust the point on the performance curves of both of the diaphragms at which they start to deflect in response to pressure impulses from the tubing circuit. The sensitivity of the aero tube circuit is therefore definitely determinable and improved. Weight 17 also deflects diaphragms 12 to such an extent that lever 40 is positively retained at its lower limit of travel except when the pressure within the tubing changes this level by deflecting the diaphragms. Since the position of lever 40 is normally fixed by the effects of weight 17, vibration of the transmitter cannot cause it to trip, the reason for this being that the right hand end of the lever 40 must move downwardly to trip the fan 36 but this movement is prevented since diaphragms 12 are normally positioned by weight 17 to fix the lower limit of travel of this end of the arm 40. Thus the only effects of vibration are to cause upward movement of the right hand end of arm 40 and downward movement of hook 42 which is in fact a movement in the latching direction with respect to fan 36. Therefore, the provision of weight 17 overcomes an outstanding

defect in mechanically tripped transmitters in that false operation caused by mechanical vibration is completely eliminated.

The system constructed in accordance with this invention is particularly adapted for use in connection with mechanically tripped impulse transmitters such as that shown in Figs. 2 to 14 of the drawings. Fig. 3 of the drawings illustrates in general the source of power for the transmitter together with the trip mechanism which is connected to the point 16 of arm 14 for releasing the power source upon the occurrence of a predetermined rate-of-rise of temperature within the protected enclosure. The source of power in this particular illustration of the impulse transmitter is a spring motor which is most clearly shown in Figs. 4 and 6 of the drawings and comprises a pair of coiled leaf springs 20 and 21 anchored in any suitable fashion to the drive shaft 23 supported in frames 18 and 19. Two springs are provided for insuring against the possible loss of a source of power in the event that one spring should fail. The motor drives shafts 24, 25, 28 and 30, also supported in frames 18 and 19, through a gear train comprising gears 25, 27, 29, 31 and pinions 32, 33, 34 and 35, whereby the motion of shaft 23 is multiplied to such a speed as to rotate the shaft 30 at whatever speed is most suitable. Fan 36 which acts as a governing device and a control device is normally prevented from rotating by means of the lever or detent 40 having a hook portion 42 for engagement with a portion of the fan 36. Lever 40 is pivoted on the adjustable pivots 44 and connected to point 16 of arm 14 by means of a perpendicular arm 39. The lever 40 is pivoted along its length at such a point that hook 42 moves through a distance equal to the deflection of either of diaphragms 12 whereby its entire motion is useful at the tripping point.

It is necessary that the degree of engagement between hook 42 and fan 36 be adjustable and, therefore, the pivots 44, supported in the yoke 46, and also lugs 48 extending from yoke 46 are held in alignment vertically in the slots 49 in frames 18 and 19 shown in Fig. 2 of the drawings. The pivots 44 are positioned vertically by an adjustment assembly comprising springs 50, a screw 51 and a nut 52 which moves horizontally and engages a lever 53 pivotally attached thereto and at its upper end to the yoke 46 whereby rotation of screw 51 controls the elevation of yoke 46 together with the degree of engagement between fan 36 and hook 42. The yoke 46 is biased downwardly by a pair of springs 50 to provide proper positioning of the entire assembly.

The trip lever 40 is arranged to be deflected in a horizontal plane as well as a vertical plane for the purpose of providing a manual release for initiating fire alarms manually. Fan 36 is provided with a slot 37 whereby deflection of lever 40 in a horizontal direction may break the engagement between hook 42 and fan 36 and allow the mechanism to operate even though the aero tube circuit has not operated. The wide slot 38 in fan 36 permits rotation regardless of the position of hook 42 provided that hook 42 is in alignment with slot 37. Lever 40 is pivoted for motion in a horizontal plane by means of a pivot member 41 extending through the block 45 which is the support for lever 40 pivoted on the pivot screws 44. As illustrated, the lever 40 includes the bent over portions 43 which engage pivot pin 41 to allow motion in a horizontal plane as well as a vertical plane. It is to be un-

derstood that any suitable pivot arrangement for obtaining motion vertically and horizontally may be used.

The manual trip mechanism includes lever 60 pivoted at 63, as shown in Figs. 2 and 6, and connected with fan 36 by means of a slotted lever 65, the slot 66 therein providing engagement with the lever 40 to impart horizontal motion thereto. The operating arm 68 is attached to lever 60 and when operated by manual pressure, forces arm 40 through lever 65 to swing the hook 42 into slot 37 of fan 36 to allow the mechanism to operate. Leaf spring 64 acts to force the lever 60 and consequently hook 42 forwardly to normal fan-locking position.

It is necessary that the manual trip mechanism (and particularly lever 60) be controlled by the motor winding mechanism to the extent that this lever, after the transmission of alarm signals, remains in a position causing hook 42 to be out of the path of fan 36, so that when the springs are rewound and then released to unwind, a restoration signal is automatically transmitted. This operation is desirable since alarm transmitters transmit alarm signals and are then in a run-down condition which requires restoration to the normal condition for again transmitting a subsequent alarm. It is further necessary that the central office attendant be informed of the fact that the alarm system has been restored to its normal condition, and therefore the hereinbefore described trip mechanism must be controlled during the winding operation and the transmission of restoration signals to start and stop the transmitter at the beginning and end of the restoration signals.

The main shaft 23 of the spring motor has fixed thereon a ratchet wheel 70. The pawl 71, which engages with the notches in ratchet wheel 70, is pinned on gear 25, as illustrated in the drawings. Gear 25 floats on shaft 23 and is normally locked against rotation as will be explained subsequently, and thus, when the shaft 23 is rotated by the key, springs 29 and 21 are tightened to fully wound condition and held there by pawl 71 in engagement with ratchet 70. Shaft 23 also rotates cam member 75 which is fixed thereto. Cam 75 includes slot 62, the leading edge of which is perpendicular to the vertical surface of the cam so that the pin 61 in lever arm 65 can drop suddenly into slot 62 to thereby provide a positive stopping motion of arm 65 and hook 42 of the tripping mechanisms. The other edge of slot 62 is beveled to lift the pin 61. Secondary cam 74 floats on shaft 23 and is provided with slot 73 which extends through an arc of several degrees with respect to the center of cam 74. Pin 77 in cam 75 extends through slot 73 and moves freely therein for several degrees of rotation of cam 75 so that there is lost motion between cam 75 and the secondary cam 74. Thus, when the shaft 23 rotates through the winding cycle, cams 74 and 75 are also rotated.

Cam 74 supports and moves pin 78 in operative relation with the arm 80 of stop lever 79 which is rotatably pinned to frame 18. Stop lever 79 also includes the projecting lug 81 which engages with a pin 82 on wheel 25 to prevent rotation of wheel 25 during the winding cycle. Arm 84 of member 79 engages the manual trip lever 60 to perform the same function as that which occurs when lever 60 is manually operated. Thus, during the winding cycle, lever arm 60 is held in a non-tripping position until pin 78 engages arm 80 to rotate member 79 in a counterclockwise di-

rection; at which time arm 81 disengages from pin 82 and arm 84 disengages from lever 60. Lever 79 is held in either of its two positions by spring 83 in engagement with lug 85. The operation of the drive shaft assembly will be described in more detail later on in the description.

Transmission of impulses is provided by impulse wheel 110 which rotates with shaft 24, driven from gear 25 through pinion 32. Impulse wheel 110 engages the contact springs 111 so that the teeth of wheel 110 intermittently open springs 111 to cause intermittent making and breaking of the transmission circuit and consequent transmission of the code signals.

The winding mechanism is provided with a key trapping device consisting of a yoke 90 on frame 18 having a keyhole 92 which is so shaped and proportioned that key 100, the handle of which has been omitted from the drawing, and the pin 101 of the key 100 can be engaged with slot 102 in hub 76 on shaft 23 for commencing the winding operation. The keyhole is so proportioned, however, that as soon as the winding operation starts, with key 100 rotated in a clockwise direction, pin 101 rotates behind the yoke 90, which thereby prevents withdrawal of the key for a certain portion of the winding cycle. While the key can be rotated counterclockwise and then removed after a short arc of winding movement, once the pawl 71 engages a notch in wheel 70 to hold the spring motor partially wound, such counterclockwise movement as would permit withdrawal of the key is prevented. The key trapping mechanism also includes a bent lever 105 which is pivoted to yoke 90 on pin 93 and influenced by spring 106 on yoke 90 in a direction toward the cam 75. However, as the key 100 is rotated, its pin 101 engages yoke 90 and then the rear side of member 105 until rotated to such a point that the transmission of a restoration signal will be assured. Lever 105 prevents extraction of the key since it is of such a length that it extends beyond the keyhole in yoke 90 whereby key 100 must be rotated until clear of the lever. It should be noticed that Fig. 11 of the drawings (wherein the illustrated parts are similar to those of Fig. 12 in which reference characters are applied) shows the cam 75 and the associated elements in such a position that pawl 71 is out of engagement with ratchet 70 whereby key member 101 may rotate past the end of member 105 at which time this member is forced back against the cam 75. Pin 101 may then engage the outer surface of that member so that, as shaft 23 rotates in a counterclockwise direction under the influence of springs 20 and 21, key 100 will be forced out of engagement with shaft 23.

Since the drawings illustrate in Figs. 2, 4, 5, 6 and 7 the transmitter in its rundown condition, the operation will be described starting with the winding operation. When key 100 is inserted in hub 76 of cam 75, pin 101 on the key engages in a slot 102 in hub 76. The key is rotated in a clockwise direction through 120° or until pawl 71 on main gear 25 engages in the first notch of ratchet 70 as shown in Fig. 8. After the pawl has engaged the first notch of ratchet 70 it is impossible to withdraw the key 100 since it is locked against withdrawal by virtue of the fact that the pin 101 has passed underneath a portion of the yoke 90 of the keytrap and thus it will be necessary to continue the clockwise rotation of the key and the winding operation before the key can be removed. Another 120° of rotation of the key engages pawl 71 with a second notch in ratchet 70,

as shown in Fig. 9, the spring motor becoming more tightly wound. In the meantime cam 75 is rotated and in so doing has turned the secondary cam 74 by means of pin 77 which engages in the slot 73 in cam 74. Therefore secondary cam 74 is no longer holding the stop lever 79 in the stopped or rundown position but the stop lever still cannot move as spring 83 is holding it in place by engaging lug 85.

Rotation of the key 100 through another 120° as shown in Fig. 10 causes the notch 62 on cam 75 to pass under pin 61 in operating arm 69. But this pin will be prevented from falling into the notch by reason of the engagement of arm 84 of stop lever 79 with the end of operating arm 60, the reason for this arrangement being the fact that the edge of notch 62 which would contact the pin 61 during the winding operation is vertical as is the surface of the pin that would contact the edge. The reason for the vertical edges is to provide a positive stop by suddenly moving lever 60, arm 65 and hook 42 in engagement with fan 36, after the transmission of the restoration signal, but if these two vertical surfaces were permitted to meet during the winding operation, it would be impossible to wind the mechanism beyond that point. Considering that the key has now been rotated through 360°, it is still impossible to withdraw the key for the reason that the pin 101 has passed under lever 105, this lever rotating about its pivot point against spring 106 to permit rotation of the key. It is to be noted that lever 105 is long enough to engage a portion of yoke 90 thereby preventing rotation beyond the plane of yoke 90, whereby key 100 is trapped in its winding position. Therefore the key must be turned through an additional 30° as shown in Fig. 11, before pin 101 becomes disengaged from lever 105. After 30° return motion key 100 may be removed owing to the fact that lever 105 is beveled at its free end, as illustrated at 107. As this additional winding is done, the pin 77 in main cam 75 takes up the slack in slot 73 in cam 74 and pulls it through a sufficient angle so that pin 78 of cam 74 engages arm 80 of stop lever 79 and rotates the stop lever through a small angle in a counterclockwise direction, thus moving the cam surface 85 past the bent portion of spring 83 where it is held as shown in Fig. 11 until forcibly restored to the position shown in Fig. 6. When stop lever 79 rotates in a counterclockwise direction, arm 84 rises above operating arm 60, allowing pin 61 to rest against the surface of cam 75, and the arm 81 of stop lever 79 is disengaged from pin 82 on gear 25 so that the spring motor is free to drive the mechanism. As the mechanism runs after being released in the above manner, code wheel 110 is rotated in the obvious manner through one round of signals which designate the restoration operation and cam 75 rotates in a counter-clockwise direction until notch 62 engages pin 61 as shown in Fig. 12, whereupon operating arm 69 moves about its pivot point 63 under the influence of spring 64, the pin 61 engaging the vertical surface of notch 62 in cam 75 to stop the mechanism. The transmitter is now in its normal or rest position and ready to be tripped for sending an alarm.

It should be noted that during the return motion of the mechanism, pin 101 of key 100 is disengaged from slot 102 owing to the fact that pin 101 engages the outer sloping surface of lever 105 which surface forces the key free of slot 102 to thereby prevent defeat of the transmitter

such as willful application of force through the key to prevent rotation of the mechanism and transmission of an alarm.

The vertical surfaces on pin 61 and slot 62 of cam 75 are of particular significance since if these surfaces were round or sloped, the motion of operating lever 60 would be slow and the entire mechanism would stop as soon as lever 65 pulled lever 40 to the right far enough to engage a portion of fan 36. This would occur considerably before pin 61 could be fully engaged with slot 62 and under this condition a fire in the protected premises could develop a pressure in the diaphragms 12 and hook 42 would operate satisfactorily, but the first operation of the mechanism would carry arms 60 and 65 further to the right and further into engagement position, and if the pressure did not last sufficiently long or if there was slight rotary motion due to some parts not being in exact alignment, the mechanism might stop because the hook 42 would engage the fan 36. However, the vertical edges on pin 61 and notch 62 permit lever 60 to assume its normal position very rapidly and thus hook 42 is moved into full engagement with fan 36 within one revolution thereof. Consequently when a fire occurs and diaphragms 12 operate, fan 36 is released and with every turn of the mechanism, levers 60 and 65 will move further and further to the left and full disengagement position under the influence of pin 61 and arm 60.

The sequence of operations described hereinbefore ends with rotation of code wheel 110 which occurs as the result of release of the driving motor at the end of the winding cycle. The teeth on code wheel 110 act on contact springs 111 to transmit a one round restoration signal through the central office for the purpose of indicating that the transmitter has been wound and restored to normal condition and is therefore prepared for transmission of an alarm signal.

The aero tube system illustrated by way of example in Fig. 1 normally consists of several circuits, each of which extends through a protected area for supervising temperature changes and detecting fire conditions within that area. If a fire should occur near one end of the circuit, pressure in the tubing will increase greatly at that end and very little if at all at the other end, this being due to the well known capillary characteristics of aero tubing which cause transmission of pressure pulses through the tubing. Assuming the above condition, the pressure builds up in the left diaphragm, this particular diaphragm being taken by way of example for purposes of illustration. This diaphragm under the influence of increasing pressure moves downwardly and lowers one end of the crossbar 14, the other diaphragm remaining stationary and serving as a pivot for the operated end of the bar 14. The central portion of crossbar 14 will descend only one-half as far as the active end of the crossbar for obvious reasons. Thus lever 40 pivots about pivots 44, the end 39 attached to crossbar 14 moving downwardly and the opposite end to which hook 42 is attached moving upwardly. Hook 42 moves a distance equal to the expansion of the diaphragm since that end of arm 40 is twice as long as the other end. When sufficient pressure and expansion of diaphragm 12 occurs, hook 42 is raised out of engagement with fan 36 thereby allowing the mechanism to start under the influence of the drive springs 20 and 21. When the mechanism

starts, the pin 61 is lifted out of notch 62 in cam 75, thereby rotating operating arm 60 about its pivot 63 so that the notched arm 65 pushes lever 40 to the left whereby the hook 42 is in line with the slot in fan 36. Thus if the pressure in the operated diaphragm 12 decreases for some reason, for instance, because of destruction of a portion of the aero tube circuit by fire, the mechanism cannot be stopped from running since hook 42 is not only raised about fan 36 but is in alignment with the slot 37.

If the fire occurs in the center of the aero tube circuit, that is, at a point equidistant between its ends, pressure is developed and rises equally throughout the tube circuit so that both diaphragms expand substantially simultaneously and at the same rate. Under these circumstances the pressure is distributed between the two diaphragms and therefore the deflection of each one is only one-half as great as it would be in the case of a similar fire condition at one end of the circuit. Crossbar 14 is lowered at both ends but only through one-half the distance at each end in comparison to the previously outlined situation where only one diaphragm could expand. Even so, the center of crossbar 14 moves the same distance that it would when the fire is at either end of the circuit, and therefore hook 42 of arm 40 moves through the same distance regardless of the location of the fire with respect to the aero tube circuit, and thus the center of the circuit is exactly as sensitive to a fire condition as the ends of that circuit. This characteristic of the tripping unit 12, 15, 14, 39, 40, 42 permits adjustment of the system to obtain sufficient sensitivity to a fire at the center of the circuit without rendering the system oversensitive to unusual heat conditions which may exist at the ends of the circuit and which determine the extent of sensitivity adjustment. The above described action of cross-arm 14 and lever 50 is the same for fires one-quarter of the way along the circuit or three-quarters of the way along the circuit, or at any other point in the circuit except that both diaphragms will expand a proportional amount and the net movement at the center of the cross-arm 14 will be the same regardless of the location of the fire with respect to the circuit.

When the transmitter is started, impulse wheel 110 rotates through five complete revolutions, thereby sending a five round signal by operating contact springs 111 which are connected to the transmission line. Cams 74 and 75 rotate counterclockwise from the normal fully wound position shown in Fig. 12 through approximately 330° until pin 78 in cam 74 engages arm 80 on stop lever 79, at which time stop lever 79 rotates in a clockwise direction to move the projection 85 to the right of the bent portion of spring 83 and bent arm 81 rotates into the way of pin 82 in main gear 25, thereby stopping the spring motor. At this time cam 75 opens the shunt springs 116, since the cutaway portion of the cam allows these springs to open. The transmitter is now in the rundown condition and require winding, as described hereinbefore.

Provision is made for manual operation of the transmitter in that horizontal pressure on lug 68 of arm 60 moves the lever 40 through the slotted link 65 so that hook 42 of arm 40 enters slot 37 and is disengaged from fan 36. Thus the transmitter is again released to operate in the manner described above in connection with initiation of an alarm by the aero tube system. Any form of

manually operated push button or lever is suitable for manually initiating an alarm but Fig. 4 illustrates by way of example only a break-glass spring-operated rotatable lever at 129, such as that shown in Patent No. 1,434,096, granted October 31, 1942. When the glass is broken, the spring is released to exert pressure on arm 58 of lever 60, whereupon pin 61 is forced out of the slot 52 after which further pressure is unnecessary since operating arm 60 is maintained in the operated position by the surface of cam 75 pressing on pin 61.

The release mechanism shown in Figs. 3, 4, 5 and 6 is adjustable by means of the screw 51 which, when rotated, forces the nut 52 in a horizontal direction thereby lifting the yoke 46 through link 53 or lowering it, depending upon the direction of rotation of screw 51. Clockwise rotation of screw 51 raises yoke 46 to decrease the pressure required to release the mechanism, since the end of lever arm 40 is also raised. Rotation of the screw in the opposite direction lowers yoke 46 and thereby increases the pressure necessary to effect release of the mechanism.

The two contacts mounted on the same support as the spring 64 are utilized for the purpose of actuating a local alarm or for any other desired purpose such as activating relays controlling a power source and the like when the transmitter is operated to transmit a signal. By reference to Fig. 6 it will be seen that the outermost long contact of this pair has a spacer engaging the upper end of the spring 64 and when this spring 64 is in its most forward position, the contacts are held open. However, when spring 64 is moved to the rear by movement of lever 60, the outer long contact of the pair follows such movement closing the two contact points and thereby permitting the closing of such local circuit as may be provided. The two contacts 116 are used in the normal manner to short out any other transmitter following this particular transmitter in the customary loop circuit so that such later transmitter cannot operate during the running of this transmitter.

It is to be noted that the aero tube system has increased sensitivity because the diaphragms are stressed a predetermined amount by means of the weight 17 whereby a downward force is exerted on the end of arm 40 which is attached to the cross-arm 14. The weight provides a fairly heavy gravitational force to perform the actual work of operating the detent when the diaphragms are expanded whereby instead of relying entirely upon the aero tube pressure and the diaphragm as the sole source of power, they merely permit the gravitational force exerted by weight 17 to take effect on arm 40 as the pressure increases in the aero tubing circuit. Weight 17 also loads or biases the diaphragms 12 so that they actually start operating at a point on the straight line portion of their expansion curves so that their action is more accurately predictable and greater movement per ounce of pressure increase is obtained. A further important advantage of the function of weight 17 is the fact that lever arm 40 is loaded in the direction in which it operates, and it is free to move in the holding direction whereby vibration does not cause accidental release, change of adjustment, or jamming of the mechanism. This feature of the invention makes a mechanically tripped transmitter practical and fool-proof. Furthermore, a series of releases by vibration would have to occur before the transmitter could be accidentally tripped

since, as is plainly evident, the fan 36 must go through a number of revolutions before cam 75 can have moved sufficiently to disengage pin 61 from slot 62 to effect actual complete release of the mechanism.

From the above description it is also evident that another important feature of this invention is the arrangement of the cross-arm 14 for providing a tripping motion which is always uniform in length regardless of the location of the fire with respect to the ends of the aero tube circuit, whereby equal sensitivity of all parts of the circuit is obtained.

A still further important feature of this invention is the provision of the key-trapping mechanism including yoke 90 and arm 105 which not only traps the key in its operating position until the transmitting mechanism is fully wound but also forces the key 100 out of engagement with the driving mechanism as the restoration signal is being transmitted. This feature of the invention makes it possible for the station operator to detect the stoppage of the mechanism during a restoration signal and prevents attempts to defeat the mechanism by applying force through the key at the time an alarm condition exists, as it is obvious that the key cannot engage the driving mechanism once the mechanism is in its normal fully wound condition. Furthermore, the key trapping mechanism simplifies the winding operation in that it compels a certain definite sequence of operations and only those operations whereby an amateur can wind the transmitter.

Another advantage derived from this invention arises from the fact that different diaphragms of the type usually used in aero tube systems have slightly different characteristics, and therefore by providing the particular tripping mechanism disclosed herein together with the adjustable yoke which supports the tripping mechanism it is possible to adjust the tension on the two diaphragms to such a degree that they perform substantially alike. Furthermore, this particular form of trip mechanism provides a single adjustment of both diaphragms.

The particular trip mechanism also makes it possible to manually operate the transmitter by means of a simple manual trip.

It is not intended that the tripping mechanism operated by the aero tube system shall be limited only to use in signal transmitters as it is equally adaptable for use in connection with automatically operated valves in fire extinguishing sprinkler systems where such valves are of the type adapted to be opened by a tripping mechanism. It is also intended that this mechanism embodying the invention disclosed herein may be adaptable to trip any form of device wherein a trip mechanism is useful and necessary. Further advantages and modifications of this invention will be apparent to those skilled in the art, and therefore it is desired that this invention not be limited to the specific mechanical elements shown herein but only as required by the prior art and the appended claims. The winding mechanism described and illustrated herein constitutes the subject matter of my copending divisional application Serial No. 453,509, filed August 4, 1942, Patent No. 2,343,964, granted March 14, 1944.

What is claimed is:

1. In combination, an aero tube fire detecting system for supervising dangerous temperature changes within a protected area, said system including pressure responsive diaphragms at each end thereof, said diaphragms being independent-

ly responsive to pressure changes in said system, a non-rigid mechanical connection directly between said diaphragms, a tripping lever pivoted for motion for exercising a control function, a link connecting said mechanical connection between the diaphragms with said lever and a weight associated with said lever in such relation thereto that a predetermined bias is exerted through the link and connection on said diaphragms, said diaphragms being free to expand without exerting force on said connection and said link.

2. In combination, a pneumatic tube system, said system including pressure responsive diaphragms at each end thereof, said diaphragms being independently responsive to pressure changes in said system, a non-rigid connection directly between said diaphragms, a tripping lever pivoted for control-exercising motion, a link connecting said connection between the diaphragms with said lever and means for exerting a predetermined bias on said diaphragms, said diaphragms being free to expand without exerting force on said connection and said link.

3. In combination, an aero tube fire detecting system for supervising dangerous temperature changes within a protected area, said system including pressure responsive diaphragms at each end thereof, said diaphragms being independently responsive to pressure changes in said system, a non-rigid mechanical connection directly between said diaphragms, a tripping lever pivoted for motion in a tripping direction for exercising a control function, and a link connecting the midpoint of said mechanical connection with said lever, said diaphragms being free to expand without exerting force on said connection and said link.

4. In combination a pneumatic tube system, said system including pressure responsive devices at each end thereof, said devices being independently responsive to pressure changes in said system, a non-rigid mechanical connection directly between said devices, a tripping lever pivoted for motion in a tripping direction for exercising a control function and a link connecting said mechanical connection with said lever, said devices being free to expand without exerting force on said connection and said link.

5. In combination, an aero tube system for detecting dangerous temperature changes within a protected area and including a pressure responsive device at each end of said system, said devices being independently responsive to pressure changes in said system, a non-rigid mechanical tripping mechanism for accomplishing a control function, a mechanical connection directly between said devices, a link connected midway of said connection and to said tripping mechanism, and means associated with said tripping mechanism for exerting a biasing force on said devices, said devices being free to expand without exerting force on said connection and said link.

6. In combination, an aero tube system for detecting dangerous temperature changes within a protected area and including a pressure responsive device at each end of said system, said

devices being independently responsive to pressure changes in said system, a non-rigid mechanical tripping mechanism for accomplishing a control function, and means associated with said tripping mechanism for exerting a biasing force on said devices, said devices being free to expand without exerting force on said tripping mechanism.

7. In combination, a pneumatic tube system for detecting temperature changes within a protected area and including a pressure responsive device at each end of said system, said devices being independently responsive to pressure changes in said system, a mechanical tripping device for accomplishing a control function, a non-rigid mechanical connection directly between said devices and a link connected midway of said connection and to said tripping mechanism, said devices being free to expand without exerting force on said connection and said link.

8. In combination, an aero tube fire detecting system of the character described including a pressure-responsive diaphragm arranged to be affected by variations of pressure in the tubing, releasing mechanism for exercising control functions, a non-rigid link so connecting said release mechanism and said diaphragm that said diaphragm can expand without exerting force on said link, and a weight associated with said link and arranged to exert a predetermined bias on said diaphragm and to operate said releasing mechanism only upon predetermined expansion of said diaphragm.

9. In combination, an aero tube fire detecting system of the character described including a pressure-responsive diaphragm arranged to be affected by variations of pressure in the tubing, releasing mechanism for exercising controlling functions and a non-rigid weighted connection between said diaphragm and said release mechanism movable to render the releasing mechanism effective only upon predetermined operative deflection of the diaphragm and movable only in the opposite direction by vibration to insure against release of the mechanism when the mechanism is subjected to vibration, said diaphragm being free to expand without exerting force on said connection.

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