Jan. 31, 1961 O. C. ENIKEIEFF 2,970,217

ROTATING SCATTERING ELEMENTS FOR X-RAY PROOF LOCKS

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Fig. 1.

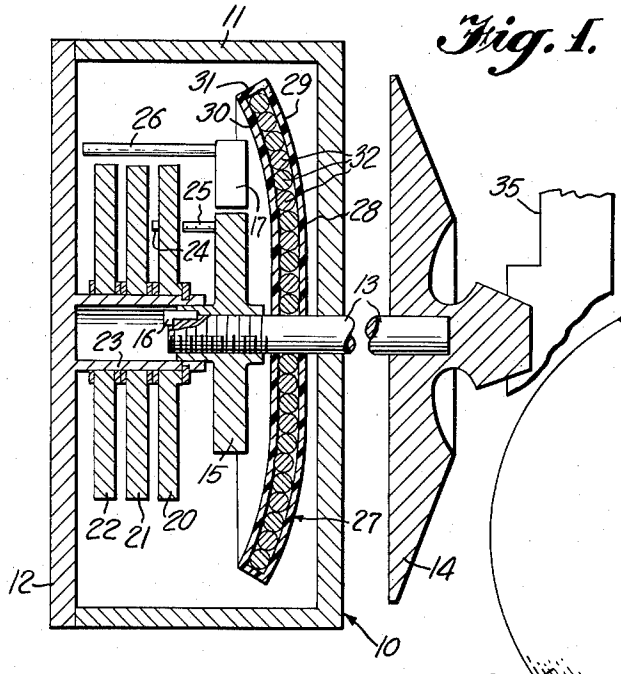


Fig 3.

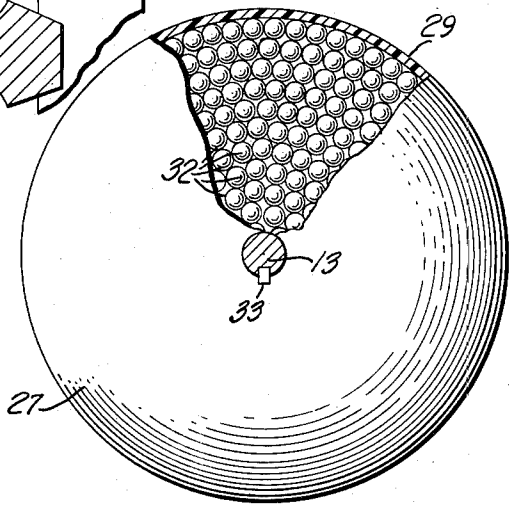
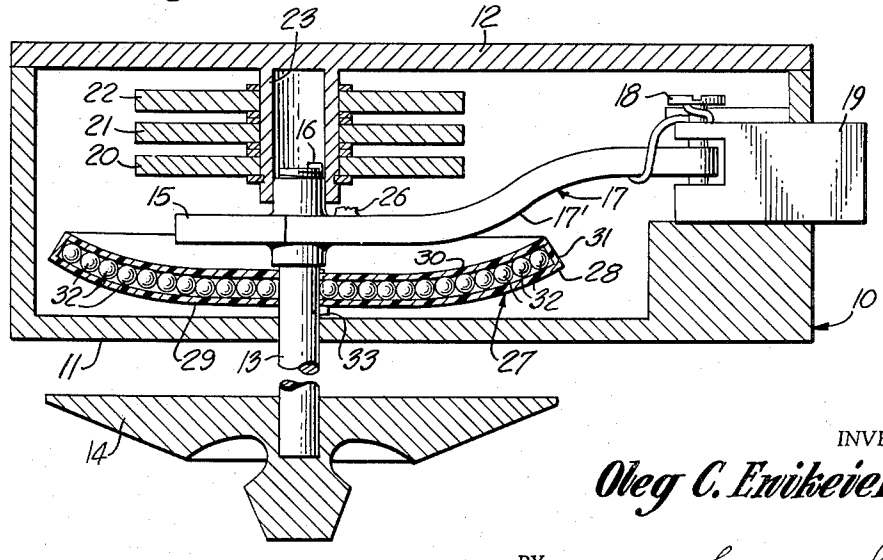


Fig. 2.



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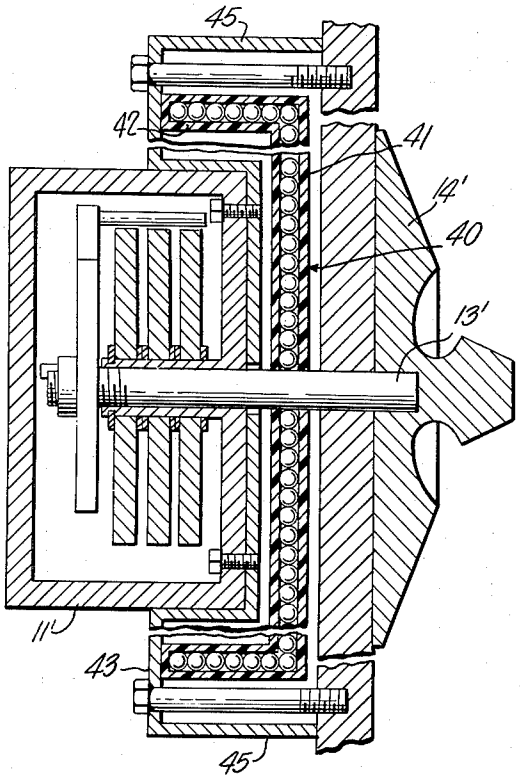
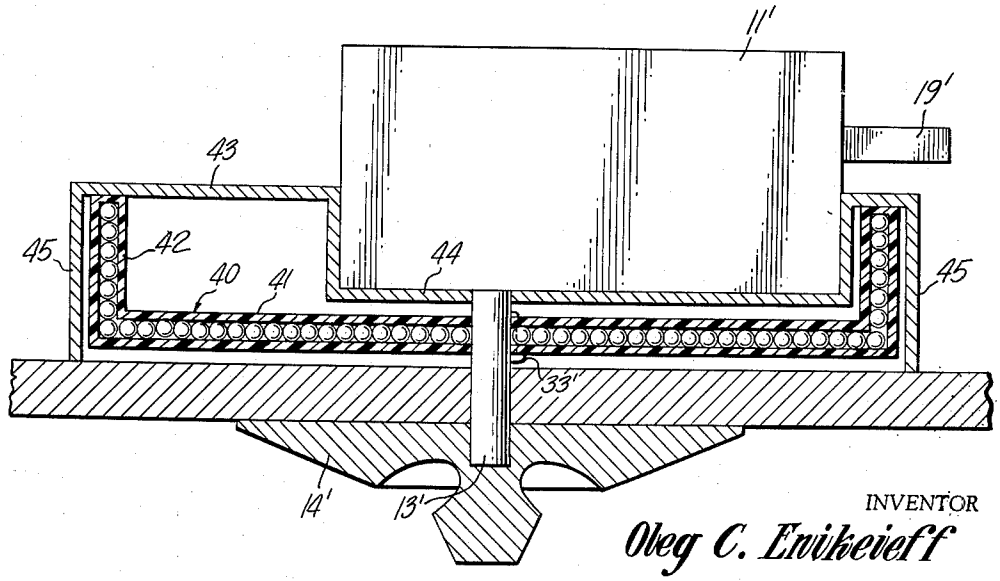


Fig. 4.

Fig. 5.



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ROTATING SCATTERING ELEMENTS FOR X-RAY PROOF LOCKS

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4 Claims. (Cl. 250—108)

The present invention relates in general to the art of combination locks, and more particularly to combination locks having a facility associated therewith for resisting compromise of security by X-ray or other radiation means.

It has been known for some time that the security of conventional combination locks in safes or other security closures may be compromised by radiography techniques as, for example, by making X-ray pictures by photographing high energy radiation which has passed through the lock mechanism. If the dial is manipulated in a special manner and the dial readings are recorded at the time the film is exposed to the radiation passing through the lock mechanism, the combination of the lock may be determined by observing the differences of photographic density resulting from the effects of the high density metallic tumblers and the voids at the location of the peripheral tumbler gatings.

In order to discourage this form of compromise of security, locks have been developed in which low density material, such as nylon, is used for the tumblers, and scattering material and shielding material is placed in the safe on all sides of the lock. A radiograph of this lock construction, when all of the lock elements are stationary does not reveal the location of the tumbler notches and hence can not be reliably used by unauthorized persons to detect the combination of the lock.

It has been discovered, however, that if an X-ray film magazine is placed in a special holder which may be removably attached to the dial of such a combination lock having low density tumbler material so that the X-ray film and dial rotate in unison, and if the dial and film holder are rotated at a uniform rate while an X-ray source placed at the rear of the safe directly behind the dial is emitting radiation, it is possible to detect the combination of the lock. By such a technique, the stationary parts of the lock including the scattering material tend to produce a uniform background on the radiograph or X-ray picture since they are in motion with respect to the film. However, those parts of the combination lock, including the three peripheral gatings on the tumbler wheels, which are in synchronous rotary motion with the film are clearly outlined and are visible in the radiograph. If suitable markers are provided on the film or the film mechanism the combination of the lock can be established as one of six possible sets of numbers. Thus the use of stationary scattering and shielding material and low density tumbler material does not, in itself, afford adequate protection against compromise of security of the safe by radiography.

An object of the present invention, therefore, is the provision of novel means in association with a combination lock for resisting compromise of security of the lock by radiation techniques.

Another object of the present invention is the provision of novel means in association with a combination lock mechanism for distorting X-ray and like radiation energy

patterns when the radiant energy is directed through the lock to prevent the production of radiographs which would reveal the combination of the lock or facilitate compromise of its security.

Another object of the present invention is the provision of a novel combination lock having rotatable scattering material disposed in protective relation to the lock mechanism to be rotated synchronously with the dial so as to prevent the production of radiographs involving the direction of X-ray energy through the lock mechanism which would reveal the locations of the tumbler wheel gatings.

Other objects, advantages and capabilities of the present invention will become apparent from the following detail description, taken in conjunction with the accompanying drawings illustrating preferred embodiments of the invention.

In the drawings:

Figure 1 is a vertical section view taken substantially in the plane of the axis of the dial spindle through a combination lock embodying the present invention;

Figure 2 is a horizontal section view taken along the line 2—2 of Figure 1;

Figure 3 is a fragmentary front elevation of the X-ray scattering shield employed in the embodiment of Figure 1, with parts broken away to reveal the internal construction of the scattering shield;

Figure 4 is a vertical section view of a combination lock assembly illustrating a modified form of the present invention; and

Figure 5 is a horizontal section view of the form illustrated in Figure 4.

Referring to the drawings, wherein like reference characters designate corresponding parts through the several figures, and particularly to the Figures 1, 2 and 3, the combination lock of the present invention, generally indicated by the reference character **10**, includes the usual casing **11** having removable rear cover plate **12**, the casing **11** being adapted to be secured to the door of a safe or other suitable security closure. The front wall of the lock casing **11** is, in accordance with conventional practice, suitably apertured to receive the dial spindle **13** therethrough. The dial spindle **13** projects externally of the lock casing **11** through the safe door and has fixed on the outer end thereof a combination lock dial **14** of conventional construction. The inner end of the dial spindle **13** is provided with the usual threaded region and associated keyway for supporting a conventional driving cam **15** in fixed angular relation to the dial spindle **13** and dial **14**. The driving cam **15** may be formed in accordance with conventional practice with a central boss which is apertured and internally threaded to be threaded on to the spindle **13**, and the aperture in the driving cam **15** may have a groove which is designed to coact with the keyway in the rearmost end of the spindle **13** to receive the usual key **16** by which these elements are selectively locked against relative movement. The driving cam **15** is peripherally gated to coact with the nose of a fence lever **17** which is pivoted on the usual lever screw **18** to the bolt **19** supported for rectilinear reciprocative movement through a side wall of the casing **11** between a projected and retracted portion relative to a conventional stationary keeper.

The combination lock **10** of the type illustrated in Figure 1 is of the peripherally gated tumbler wheel pack type, wherein the tumbler wheels **20**, **21** and **22** are journaled on a fixed tumbler post **23** formed as an integral tubular extension on the rear cover plate **12**. The tumbler wheels **20**, **21** and **22** have the usual lost motion connection between the rearwardly progressing pairs of tumbler wheels, the tumblers **20** and **21** having a rearwardly projecting

driving pin 24 cooperating with the radial extension of a fly or washer associated with the adjacent tumbler wheel. The forwardmost tumbler 20 is driven in conventional fashion by a rearwardly projecting drive wheel 25 on the driving cam 15. The fence lever 17 has the usual rearwardly projecting fence 26 which overlies the periphery of the tumbler wheels 20, 21 and 22, the coaction of the driving cam, fence lever and tumblers being entirely conventional and well understood in the art.

The tumblers 20, 21 and 22 may be constructed of metal, or may be constructed of low density material such as nylon and the like.

In order to protect the lock mechanism against surreptitious detection of the location of the tumbler gatings, and thereby detection of the lock combination, by radiography methods, a radiation scattering element 27 may be provided within the lock casing 11 between the driving cam 15 and the forward wall of the casing 11 to scatter the radiation directed through the lock casing from such angles as would reveal on an X-ray film, the internal mechanism of the lock. This radiation scattering element 27 may be constructed in the form of a disk-shaped or saucer-shaped housing 28 having spaced front and rear walls 29 and 30 and a peripheral wall 31, formed of plastic or any other convenient material, together with a plurality of X-ray scattering particles or bodies 32, which in the preferred example are 3/16" diameter lead balls filling the space between the walls of the housing 28. The X-ray scattering element 27 is centrally apertured to receive the dial spindle 13 therethrough and is keyed to the dial as by the key 33 to cause the radiation scattering element 27 to rotate with the dial and dial spindle.

As shown in Figures 1 and 2, the scattering element housing 28 may be curved rearwardly in the region of its periphery and be of substantially greater diameter than the driving cam or tumblers to increase the area of radiation scattering. When the periphery of the scattering element housing 28 extends rearwardly sufficiently to embrace part of the driving cam 15 and fence lever 17 it will be necessary to distort the fence lever 17 out of its usual planar condition as by providing the bend 17' shown in Figure 2 in the central region of the fence lever so as to offset the pivoted end thereof rearwardly of the fence lever nose.

As was explained earlier, it would be possible to compromise the security of conventional combination locks, even if they were provided wtih tumbler wheels of low density material by providing an X-ray film holder or jig, such as is indicated by the reference character 35 in Figure 1, which may be removably supported on the knob of the dial and providing an X-ray source or other radiation source at the rear of the safe or security closure generally in alignment with the axis of the dial spindle so as to direct the radiation energy forwardly through the lock mechanism and on to the film in the film holder 35. However, since the radiation scattering element 27 incorporated in the above-described combination lock is interposed in the path of the radiation energy between the radiation source and the film holder 35 rotates at a synchronous angular speed with the dial 14, the scattering material remains stationary relative to the film in the film holder 35 and so distorts the photographic image as to prevent reduction of the scattering pattern to background status and thus prevent recording of a visible outline of the lock parts including the tumbler wheels which remain stationary relative to the dial during manipulation of the dial. Thus an effective countermeasure technique is provided to prevent compromising of the lock security by such radiography techniques.

It will be apparent that many variations may be made in the placement of the radiation scattering element so long as it is so associated with the dial spindle as to cause it to be simultaneously driven with the dial. Thus the radiation scattering element may be disposed at other locations within the lock casing as, for example, by supporting it rearwardly of the driving cam in a conventional combination lock wherein the tumbler wheels are located forwardly of the driving cam in coaxial relation with the spindle.

Alternately, the radiation scattering shield may be located externally of the lock casing as is illustrated in Figures 4 and 5. In this embodiment, the radiation scattering element, designated by the reference character 40, is keyed to the portion of the dial spindle 13' projected forwardly of the lock casing 11'. It is constructed in similar manner to that described in connection with the shielding element 28 and preferably comprises a pair of inner and outer walls of plastic or other suitable material between which are interposed a plurality of radiation scattering particles such as 3/16" diameter lead balls. The radiation scattering element 40 in this embodiment is preferably shaped to provide a disk-like portion 41 and a rearwardly projected integral flange portion 42 extending close to the bolt 19'. It will be appreciated that the inner diameter of the peripheral flange portion 42 must be sufficiently great to clear the horizontal span of the lock casing 11'. Suitable mounting means will have to be provided, of course, for the lock casing 11' to support it in rearwardly spaced relation from the safe door or the like on which it is mounted so that the radiation scattering element 40 may be supported between the front wall of the lock casing 11' and the supporting surface. This may be accomplished, for example, by providing a suitable mounting plate 43 having a central portion 44 to which the lock casing 11' may be secured in the conventional manner, and which has a peripheral wall 45 adapted to bear against the inner surface of the safe door to maintain the proper spacing for accommodating the radiation scattering element 40.

While several specific embodiments of the present invention have been particularly shown and described, it is apparent that various modifications may be made in the invention without departing from the spirit and scope thereof, and it is desired, therefore, that only such limitations shall be placed thereon as are imposed by the appended claims.

What is claimed is:

1. In a combination lock of the type having a plurality of rotatable tumbles and a rotatable spindle for adjusting the tumblers, the improvement comprising means for resisting compromise of the security of the lock by radiography techniques including a radiation scattering shield supported on the spindle in concentric relation therewith having radiation scattering means disposed in a pattern extending in forwardly shielding relation to the tumblers to intercept radiation energy directed through the tumblers along radiation axes extending generally along the spindle which would yield a radiograph image of the tumblers and scatter the radiation energy to prevent recording of a readable image of the tumblers which would reveal their angular position, and means for coupling said scattering shield to such spindle to rotate synchronously with the spindle.

2. A combination lock of the type having a plurality of coaxially supported peripherally gated tumbler wheels and a rotatable dial spindle extending in coaxial relation forwardly of the tumbler wheels for adjusting the tumblers including means for resisting compromise of the security of the combination lock by radiography techniques comprising a shield member supported on said spindle forwardly of the tumbler wheels having a central aperture for accommodating such spindle, said shield member having an expanse radially of said spindle to intercept radiation energy directed through the tumbler wheels along radiation axes lying within selected small angles of inclination relative to the spindle axis and having radiation scattering means extending substantially throughout the expanse of said shield member to scatter the radiation energy intercepted by the shield member and thereby distorting the exit radiation pattern to prevent recording of a readable image of the tumblers which would reveal the angular position of the tumbler gatings,

and means for holding said shield member against rotation on said spindle to cause said shield member and spindle to rotate in synchronism.

3. In combination with a combination lock of the type having a plurality of coaxially supported peripherally gated tumbler wheels and a rotatable dial spindle extending in coaxial relation forwardly of said tumbler wheels for adjusting the tumbler wheels, a radiation scattering device for resisting compromise of the security of the lock by radiography techniques comprising a generally disk-like shield member supported on said spindle forwardly of the tumbler wheels including a housing having spaced front and rear walls and a peripheral wall defining chamber therein and radiation scattering means substantially filling said chamber, said radiation scattering means extending over an expanse radially of said spindle to span a diameter greater than the diameter of the tumbler wheels to intercept radiation energy directed through the tumbler wheels along radiation axes lying within selected small angles of inclination relative to the spindle

axis and scatter the radiation energy to distort the exit radiation pattern and prevent recording of a radiograph image which would reveal the locations of the tumbler gatings, and means for holding said shield member against rotation relative to said spindle to cause said shield member and spindle to rotate in synchronism.

4. The combination recited in claim 3 wherein said radiation scattering means includes a plurality of lead spheres arranged in coplanar relation with adjacent spheres in surface contact with each other and wherein said front and rear walls of said shield member housings are spaced uniformly from each other a distance corresponding to the diameter of the lead spheres.

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