

Oct. 12, 1948.

A. H. FEIBEL

2,451,282

X-RAY PROTECTIVE DEVICE

Filed Dec. 16, 1943

2 Sheets-Sheet 1

Fig. 1

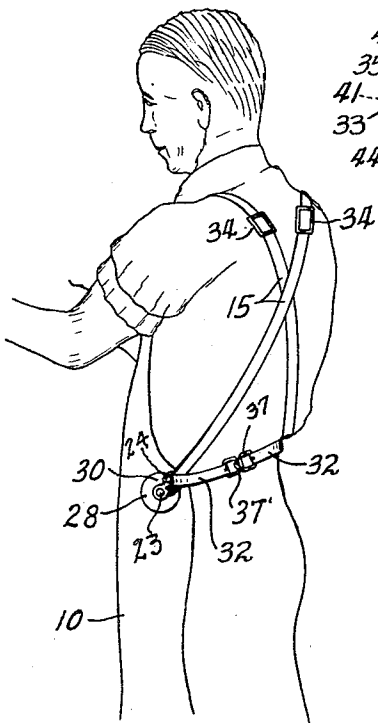
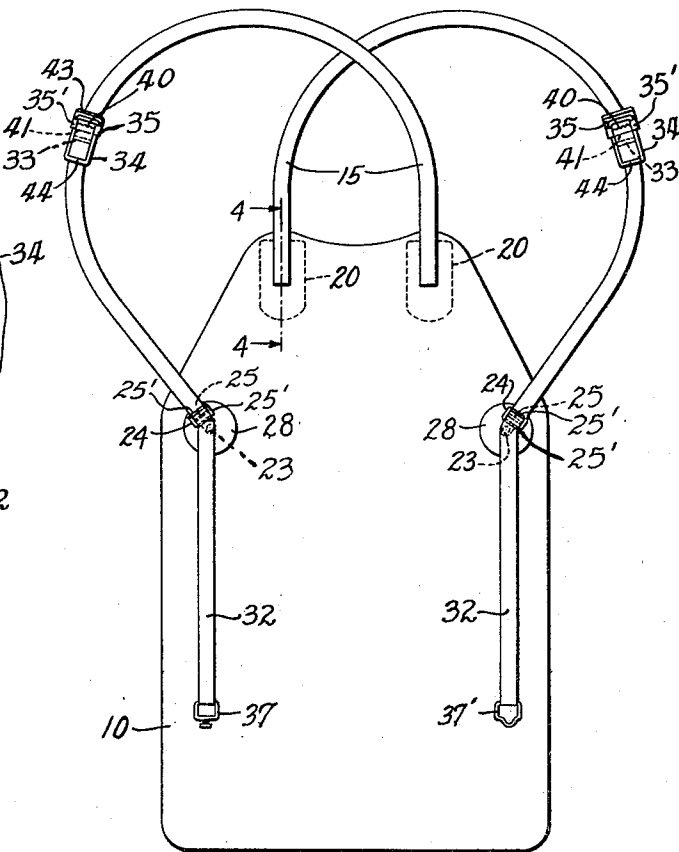


Fig. 2



Inventor

Adolph H. Feibel

By

Morschel and Feibel

Attorneys

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Fig. 3

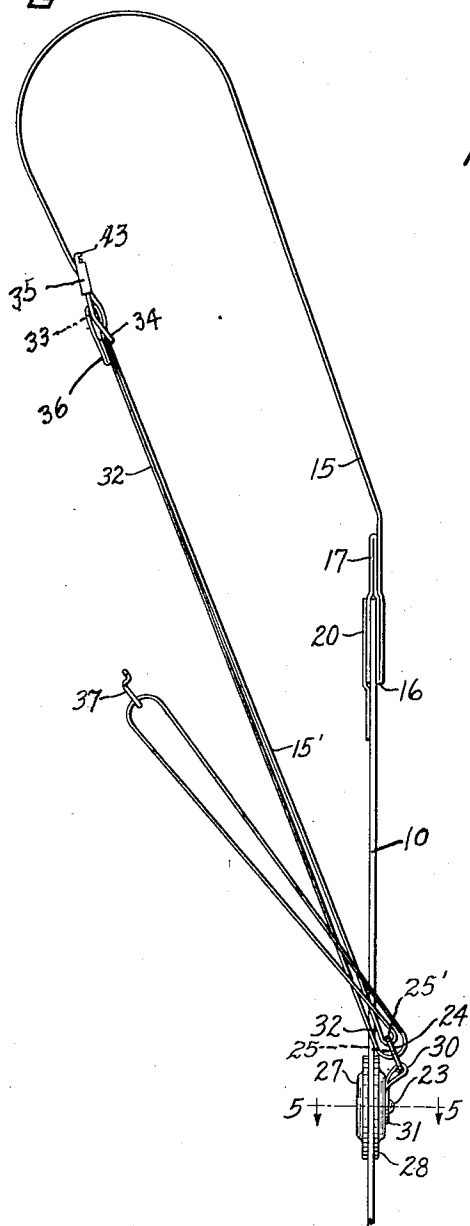


Fig. 4

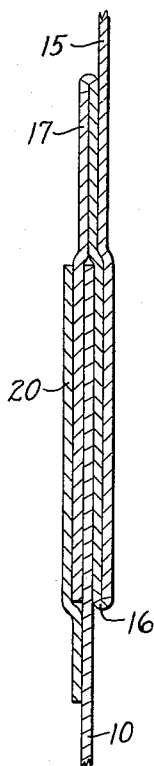
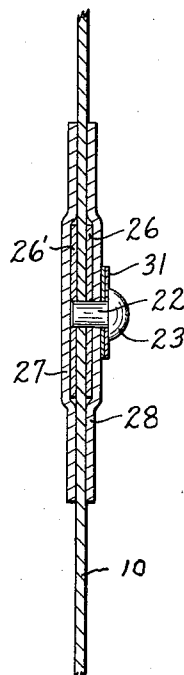


Fig. 5



Inventor

A. H. Feibel

By

Marshall & Feibel

Attorneys

# UNITED STATES PATENT OFFICE

2,451,282

## X-RAY PROTECTIVE DEVICE

Adolph H. Feibel, Cincinnati, Ohio, assignor to  
The Kelley-Koett Manufacturing Co., Inc.,  
Covington, Ky., a corporation of Ohio

Application December 16, 1943, Serial No. 514,473

15 Claims. (Cl. 250—108)

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This invention relates to a protective apron for use in X-ray work.

As is well known, undue exposure to X-ray emanations has resulted in serious injury, as for example to operators who are apt to be exposed to the direct rays and also to indirectly disseminated rays. Although X-ray machines today are provided with various protective linings, etc., nevertheless there is always the danger that an operator over a prolonged period may be injured through over exposure as stated. The present invention, therefore, has to do with an apron, to be worn by the operator, which is such as to add substantially to the protection afforded the operator against X-ray emanations.

One of the principal objects of the invention is to provide such an apron which is of unusual effectiveness in protecting the operator; and also which may be simply and readily adjusted to fit operators of different sizes.

Another object of the invention is to provide such an apron constructed so that when the supporting means therefor has been adjusted to fit an operator, it may be readily put on and removed in a simple way and without the necessity of varying its desired adjustable setting.

Another object of the invention is to provide such an apron in which a substantial portion of the weight is carried by the operator's hips rather than his shoulders.

Other objects and advantages of the invention will be apparent from the description and claims hereinafter set out, and the accompanying drawing.

In the drawing, in which like characters of reference designate like parts throughout the several views:

Fig. 1 is a somewhat diagrammatic representation of the apron of this invention illustrated in position upon an operator;

Fig. 2 is a front view of the apron showing the supporting straps, and adjustable and strap connecting means;

Fig. 3 is an enlarged fragmentary side elevation of the apron and its supporting straps and adjustable means;

Fig. 4 is an enlarged fragmentary sectional view along the line 4—4 of Fig. 2; and

Fig. 5 is an enlarged fragmentary sectional view along the line 5—5 of Fig. 3, with certain parts being shown in elevation to more clearly show certain details of construction.

In the embodiment of the invention which is illustrated in the drawing the body of the apron 10 is of such form that when in position on the

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operator it extends over those portions of the operator's body, including the torso, which will be most likely to receive any direct or disseminated X-ray emanations. The body of the apron consists of a sheet of natural rubber or synthetic material (such as Buna S synthetic rubber) properly leaded to act adequately to intercept X-rays emanating directly or indirectly from the machine.

Connected to the upper end of the apron for supporting it are two straps of flexible material, such as canvas webbing or other textile strap material strong enough to support the heavy leaded apron body, each strap being designated by the numeral 15, which straps pass over the operator's shoulders and cross each other at the back in somewhat the arrangement of a pair of suspenders. Where each of these straps 15 is connected to the apron, the straps, as shown, are folded at the end which is to be connected, in the manner indicated in the enlarged section in Fig. 4. Each strap 15 is folded upon itself to provide a double thickness as indicated by the numeral 16 and the overturned portion providing this double thickness is of sufficient length so that it may be again folded upon itself as indicated at 17 so that the portion 17 and the double portion 16 may receive between them the end of the apron 10 to which each strap is to be fastened. The straps, as thus folded, are fastened to the apron 10 as by sewing, the fastening stitches passing through leaded apron 10 as well as through the three layers of the strap which include the double folded portions 16 and 17. As such stitching might leave small openings which would pass completely through the points of connection of the straps to the apron, a section 20 of leaded rubber, or other such effective shielding material, is cemented to the inside of the apron so as to completely overlie all of the stitched portions of each strap connection with the apron and thus prevent passage of X-rays through the stitching openings in this strap connection zone. Furthermore, as so connected, with the three thicknesses of strap connected to the apron, upon its inner and also its outer sides as indicated in Figs. 3 and 4, the upward pull of the straps on the supporting apron will be exerted from both the front and back sides of the apron to thus more securely and effectively support the very heavy leaded apron.

Fastened to the apron portion 10 at positions adjacent or just above the hips of the wearer or operator are rivets 22 each having a protruding portion with an enlarged head 23 to receive a fastening loop shown as a slidable metal loop member 24 having a cross bar 25 to provide two

large openings through which the strap may be adjustably passed, said loop member 24 serving to hold the strap in properly adjusted position during use.

As shown in Figs. 3 and 5 this rivet 22 extends through aligned openings in two washers designated by the numerals 26—26', which are placed upon opposite sides of the body portion of the apron 10 and through a corresponding opening in the apron itself. Upon the inside or back side of the apron is a section or disc 27 of protective material, such as that in the apron body, which is cemented to the apron 10 to completely close over the openings in which the rivet 22 is positioned and which likewise serves to hold the washer 26' and the covered end of the rivet 22 firmly in place.

A corresponding portion or disc 28 is fastened to the outside or front of the apron with an opening through which the rivet passes, to hold the washer 26 in place and to assist in adequately securing this rivet 22 and holding it in place against the strains due to the weight of the apron and its use.

Each strap is slidably mounted to pass through its corresponding loop receiving member 24, and around one of the outer bars thereof indicated at 25' and the cross bar 25 thereof, and the member 24 has one of its outside bars 25' movably held within a connecting loop 30 formed by a double strap portion the two adjacent ends of which are indicated by the numeral 31, and which in turn have openings therein which receive the rivet 22 with the head 23 thereof held thereagainst, whereby the rivet holds the double strap portion 31 to the apron which in turn holds the loop member 24 in place. This illustrates a simple construction for affixing the loop member 24 at the proper places on the apron to be adjacent the hips of the operator and to permit of passing the strap therethrough and doubling it back upon itself in the manner above described.

For purposes of simplicity in description a portion of the strap which passes through and is doubled back upon itself, and which represents the opposite end of the strap from that which is attached at the top of the apron is indicated by the numeral 32, the main portion of the strap which passes through the loop member 24 being indicated by the numeral 15', as shown particularly in Fig. 3. The end of the portion 32 of the strap is looped over the center bar 33 of a buckle on slidably adjustable member 34, the looped over portions of the strap being riveted or sewed or otherwise adequately secured together at 36 to fasten this member 34 to this end portion 32 of the strap, and the main portion of the strap 15' referred to passing through this buckle so that by moving the buckle along the portion 15' and moving the strap also through the loop member 24 the effective length of the strap may be adjusted as desired. The slide member or buckle 34 is provided with suitable means to permit ready movement of the buckle with respect to the portion 15' of the strap and also to affix the buckle sufficiently to hold it in that position for a more or less extended period. As shown in the drawing this is accomplished by means of a slidable toothed crosspiece 35, which may be moved to such position that as the weight of the apron tends to pull down it will cause the toothed member to hold against the strap portion 15' and prevent slip but which will also readily release when the pull is changed so that the strap may be lengthened or shortened as desired. By means

of this arrangement each strap may be lengthened or shortened to fit the operator, his height and weight, etc. The illustrative form of slide member or buckle for permitting ready adjusting movement of the end of each strap portion 32 with respect to the main body portions 15 and 15' of the strap is shown as constructed for permitting ready adjustment but firmly clamping and holding the two parts of the strap in any selected adjusted position, to give desired length, with the very considerable weight of the leaded apron being sufficient to hold the clamping portions firmly in adjusted position. Because of the great weight of the leaded apron it is desirable that the adjustments may be such that it will fit the operator most satisfactorily and most comfortably, and the type of construction illustrated permits of adjustment to any desired position and firmly holding the parts 32 and 15—15' in that position with the weight of the apron assuring tight clamping or holding of the parts. Also this construction permits adjustment to any desired position to suit the body requirements.

As shown particularly in Figs. 2 and 3, the member 34 is a rectangular looped member, such as can readily be made from a metal stamping, bent in angular form as shown most clearly in Fig. 3. The open space within the member 34 is provided with a cross bar 33, positioned approximately at the position of angular bend, about which the free end of the portion 32 of the strap is looped and then stitched or otherwise fastened to the portion 32 as indicated at 36, thus connecting the member 34 to the end of the portion 32 of the strap. The upper end of the member 34, as shown in Fig. 2 is preferably serrated across its inside edge along the top of the opening in the member 34, these serrations or teeth 40 serving to bite into the portion 15—15' of the strap under pull, such as that which is occasioned by the weight of the very heavy leaded apron.

The member 35 may also be a formed metal portion having an opening stamped out of the flat portion, through which the portion 15—15' of the strap passes and may be adjusted with respect to the member 34. This cross member, the bottom of which is indicated in Fig. 2 by the dotted line 41 which marks the bottom of the member 35, has its upper edge preferably serrated to provide teeth, and as these teeth, in the position shown in Fig. 2, are approximately behind the teeth 40 at the top of the member 35, they are not shown in Fig. 2.

This member 35 has portions 35' on each side, which may be formed by bending the sheet metal of which the member 35 is formed so that they slidably embrace the side pieces of the member 34 to permit movement of the member 35 in either direction with respect to the member 34. The overturned portion 43 at the top of the member 35 is primarily to provide a curved portion on the side toward the strap portion 15—15' to permit more ready movement and adjustment and to provide an overhanging portion which thus somewhat protects the upper end of the member 34 from accidental contact with projections or with the hands of the operator, and thus reduces the likelihood of the buckle being released and the adjusted position being changed. When the desired adjusted position is reached any pull tending to move the members 34 and 35 relatively in the opposite direction will bring the cooperating teeth thereon into clamping position so that the strap por-

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tion 15' will be tightly clamped between them. And, as stated, the weight of the leaded apron is so very substantial that it will exert sufficient downward pull to insure holding these parts together especially when the teeth are provided.

As shown in Figs. 2 and 3, in assembling the construction the end of the strap is passed through the opening in the member 35 and then through the upper opening and below the holding edge 40 in the member 34, around the cross bar 33, and then through the lower opening and below the lower end or cross piece 44 of the member 34. And having been looped through the member 34, the free end is then passed through the lower opening of the member 34, around the cross bar 33 and between the cross bar 33 and portions 15' of the strap and is then looped downwardly and the end overturned as shown and fastened to the strap portion 32 so that the parts are held together. This arrangement, together with the looped portion of the strap which passes through the loop member 24, gives a construction whereby the parts will not become lost and whereby suitable fixity and strength of the various parts are provided to sustain the heavy leaded apron. When it is desired to effect adjustment the operator moves the parts 34 and 35 to bring the teeth out of holding relation and the portion 15—15' of the strap may then be moved freely with respect to the members 34 and 35.

Slidably mounted upon each strap, in the doubled portion extending beyond the loop member 24 is a part of a clasp or connecting member, one of these parts 37 having provisions such as a hook member which may be readily inserted and fastened into the other part 37' of the clasp, the free ends of the strap members which are shown in depending position in Fig. 2, and in elevated, intermediate position in Fig. 3 being held connected together in substantially horizontal position across the back of the operator adjacent the waistline when these two members of the clasp are connected.

When the length of the straps has been adjusted to suit the particular operator the apron can be readily put on or taken off over the head of the operator as the total length of strap available on each side and across the operator's back between the loop members 24 is such that the straps may slide through these loops to permit of readily loosening the straps by thus varying the length as may be required to accomplish this. And, as shown, the straps come through from across the operator's back through the loop members 24 and then out over the back of the user of the apron thus producing a self-locking effect, due to friction of the strap faces against each other and the angular pull at the loop members 24.

The doubled portions of each strap over the cross bars 25—25' prevent the straps from slipping out of the loop members 24, and also the respective clasp members 37 and 37' are preferably of such over-all dimensions that they will not pass through the openings in the member 24 and thus the properly adjusted supporting straps may be retained in the desired arrangement and the clasp members may be readily clasped or unclasped and the apron readily removed without any danger of the straps pulling through the loop member 24 or getting out of adjustment. By this arrangement whereby the adjustable member 34 is upon the one end of the strap portion 32 and the variable length portion 15' of the

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strap passes through such members 34 to be held in adjusted position therein but not removable therefrom a loop of strap is provided which passes around the bars 25—25' and the member 34 is of such size that it cannot pass through the openings in the loop member 24. Therefore the parts having once been so assembled can be freely adjusted to fit the size of the operator, can be clasped or unclasped, to permit of the operator readily putting the apron on or taking it off with ample length of strap to facilitate this, and also with the arrangement such that the member 34 can be left in adjusted position, or even if it should come loose nevertheless the general arrangement and adjustability of the parts would be retained and it would be a very simple matter for the operator to readjust either or both of the members 34, as desired, to secure the desired strap length.

While the device herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of device, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, each strap having one end thereof connected adjacent one side of the upper end of the apron, a strap supporting loop member connected adjacent each side of the apron to lie approximately at the waistline of the operator when in use, each of said attached straps passing diagonally across and being looped through the supporting loop member at the opposite edge of the apron body, the free end of said strap having attached thereto an adjustable member which slidably receives the main portion of the strap and has means for holding the adjustable member in adjusted position on said main portion of the strap, a clasp member slidably mounted between the over-turned portions of the strap beyond the supporting loop member of each strap, said clasp members being constructed so that they may be readily connected and disconnected when the doubled portions of the two straps are pulled into substantially horizontal position across the back of the operator, and each said buckle and each said clasp member being of such dimensions that it will not pass through said supporting loop member whereby the effective length of the supporting strap may be varied but the strap will be permanently affixed at the top of the apron and affixed in slidable relation through the cooperating loop at the side of the apron.

2. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator; means carried by the body portion of the apron for slidably receiving the straps in spaced apart position, cooperating clasp members carried by the respective ends of said straps for connecting said straps across the operator's back, and means for adjusting the length of said straps according to the size of the operator.

3. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, means carried by the body portion of the apron for slid-

ably receiving the straps in spaced apart position, cooperating clasp members carried by the respective ends of said straps for connecting said straps across the operator's back, and means for adjusting the length of each of said straps and including an adjustable member affixed to one end of the strap and adjustable with respect to the cooperating part of the main portion of the strap.

4. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, each strap having one end thereof connected adjacent one side of the upper end of the apron, a strap supporting loop member connected adjacent each side of the apron, each of said attached straps passing diagonally across the other and being looped through one of said supporting loop members at the opposite edge of the apron body, adjustable means connected to the free end of each said strap and having means for slidably receiving the main portion thereof and comprising means constructed to hold said straps and adjustable means in a fixed adjusted position or to release them for guided slidable movement of the strap and holding means to vary the length of the strap to fit the size of the operator, and a clasp member slidably positioned in the doubled portion of each of the said straps, said clasp members being constructed for connection to hold the doubled portions of the two straps in substantially horizontal position across the back of the operator.

5. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, each strap having one end thereof connected adjacent one side of the upper end of the apron, a strap supporting loop member connected adjacent each side of the apron, each of said attached straps passing across the other and being looped through the supporting loop member at the opposite edge of the body whereby the straps cross the operator's back diagonally when in use, adjustable means carried by the end of each of the straps beyond the looped portion which is doubled through the supporting loop member therefor, and having means constructed for adjustably receiving the main portion of the strap and cooperating means for holding the main portion and said end portion of the strap in adjusted position to fit the body of the operator, a clasp member slidably mounted within the doubled portion of each of said straps said clasp members being constructed for cooperative connection to hold the doubled ends of the two straps together in substantially horizontal position across the back of the operator, and each clasp member being constructed to provide stop means for cooperating with a stop portion of the cooperating loop member for preventing the doubled end of each strap from passing through its said supporting loop member when the clasp members are unfastened.

6. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, means carried by the body portion of the apron for slidably receiving looped portions of the straps in spaced apart position, cooperating clasp members carried by the respective looped end portions of said straps for connecting said straps across the operator's back, and means for

adjusting the length of said straps according to the size of the operator.

7. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, strap retaining means carried by the body portion of the apron for slidably receiving looped portions of the strap in spaced apart position and comprising means for guiding the straps in slidably adjustable relation and means for limiting movement of the straps therein, cooperating clasp members carried by the respective looped end portions of said straps having cooperating means thereon for connecting said straps across the operator's back, and means for adjusting the length of each said strap according to the size of the operator, said clasp means being constructed for engagement with said strap retaining means at a predetermined end of range of slidable movement of the strap to prevent withdrawal of each strap from its respective slidable supporting member when the clasp members are disconnected.

8. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, means carried by the body portion of the apron for slidably receiving looped portions of the straps in spaced apart position, cooperating clasp members carried by the respective looped end portions of said straps for connecting said straps across the operator's back, and means for adjusting the length including an adjustable member affixed to the end of the strap in the looped portion and adjustable with respect to the cooperating part of the main portion of the strap.

9. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, each strap having one end thereof connected adjacent one side of the upper end of the apron, a strap supporting loop member connected adjacent each side of the apron, each of said attached straps passing across the other and being looped through a supporting loop member at the opposite edge of the apron body, adjustable means connecting the free end of said strap to the main portion thereof to provide a doubled portion and constructed to vary the length of the strap to fit the size of the operator, and a clasp member slidably positioned in the doubled portion of each said strap, said clasp members being constructed for connection to hold the doubled portions of the two straps in substantially horizontal position across the back of the operator.

10. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, means carried by the body portion of the apron for slidably receiving looped portions of the straps in spaced apart position, means resistant to X-ray penetration for preventing X-ray penetration through said apron at the place of attachment of said means, cooperating clasp members carried by the respective looped end portions of said straps for connecting said straps across the operator's back, and means for adjusting the length of said straps according to the size of the operator.

11. An X-ray protective apron comprising a

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body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, means carried by the body portion of the apron for slidably receiving looped portions of the straps in spaced apart position, said means comprising stiff discs affixed on opposite sides of said apron body and means resistant to X-ray penetration for covering over said discs to prevent X-ray penetration through said apron body at the place of attachment of said discs, cooperating clasp members carried by the respective looped end portions of said straps for connecting said straps across the operator's back, and means for adjusting the length of said straps according to the size of the operator, said clasp means being constructed to prevent withdrawal of each strap from its respective slidable supporting member when the clasp members are disconnected.

12. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps for supporting said apron from the shoulders of the operator, means resistant to X-ray penetration covering over the place of attachment of said straps with the apron top, means carried by the body portion of the apron for slidably receiving looped portions of the straps in spaced apart position, cooperating clasp members carried by the respective looped end portions of said straps for connecting said straps across the operator's back, and means for adjusting the length including an adjustable member affixed to the end of the strap in the looped portion and adjustable with respect to the cooperating part of the main portion of the strap.

13. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, straps supporting said apron from the shoulder of the operator, strap retaining means carried by the body portion of the apron for receiving said straps in spaced apart position and including means for guiding said straps in slidably adjustable relation, means for adjusting the length of said straps according to the size of the operator, a portion of each of said straps being looped over its respective retaining means and secured to said adjusting means to prevent withdrawal thereof from said retaining means, and cooperating clasp members carried by said looped portions of said straps for connecting said straps across the back of the operator.

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14. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, a pair of supporting straps each connected at one end to the top of said body portion and adapted to pass over the shoulders of the wearer of said apron, cooperating clasp members carried by said straps at positions spaced from said connected ends thereof for releasably coupling said straps together, and means carried by said body portion at positions adjacent the hips of the wearer for connecting each of said straps to said body portion at a point between said connected end thereof and said clasp member thereon to cause a substantial portion of the weight of said apron to be carried by the hips rather than the shoulders of the wearer.

15. An X-ray protective apron comprising a body portion composed of a flexible material resistant to X-ray penetration, a pair of supporting straps each connected at one end to the top of said body portion and adapted to pass over the shoulders of the wearer of said apron, cooperating clasp members carried by said straps at positions spaced from said connected ends thereof for releasably coupling said straps together, means carried by each of said straps between said connected end thereof and said clasp member thereon for adjusting the effective lengths of said straps, and means carried by said body portion at positions adjacent the hips of the wearer for connecting each of said straps to said body portion at a point between said connected end thereof and said clasp member thereon to cause a substantial portion of the weight of said apron to be carried by the hips rather than the shoulders of said wearer.

ADOLPH H. FEIBEL.

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The following references are of record in the file of this patent:

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**Certificate of Correction**

Patent No. 2,451,282.

October 12, 1948.

**ADOLPH H. FEIBEL**

It is hereby certified that errors appear in the above numbered patent requiring correction as follows:

In the grant, lines 2 and 13, and in the heading to the printed specification, line 4, for "The Kelley-Koett Manufacturing Co., Inc." read *The Kelley-Koett Manufacturing Company*; column 3, line 53, for "buckle on" read *buckle or*; column 5, line 14, for the numeral "34" read *24*; column 8, line 9, claim 7, for the word "strap" read *straps*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of March, A. D. 1949.

[SEAL]

**THOMAS F. MURPHY,**  
*Assistant Commissioner of Patents.*