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APPARATUS FOR USE IN OBSERVING MOVING OBJECTS, SUCH AS  
THE WEB OF A MULTICOLOR OR OTHER PRINTING MACHINE  
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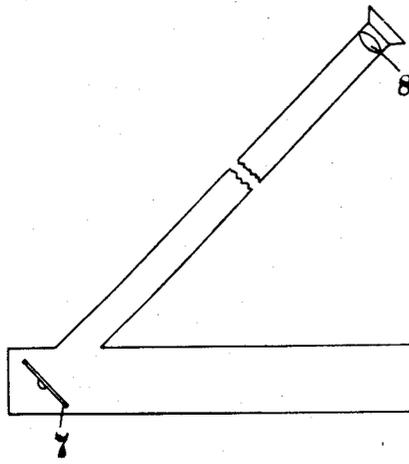


Fig. 1.

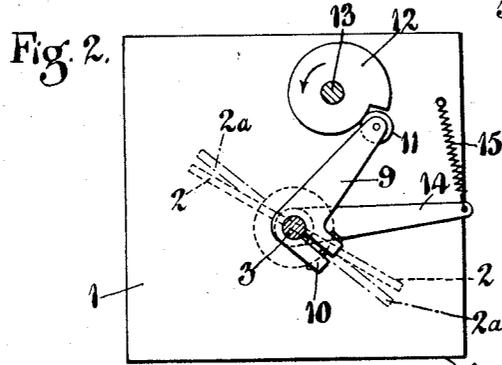


Fig. 2.

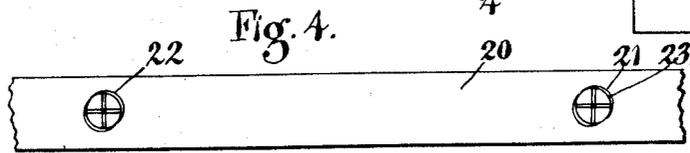


Fig. 4.

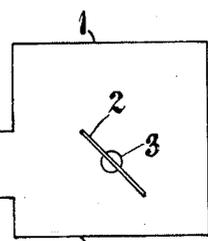


Fig. 5.

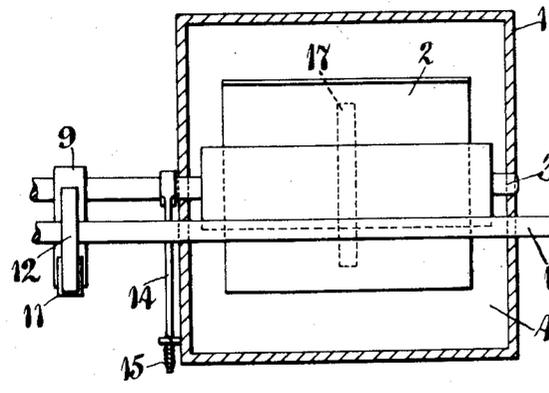
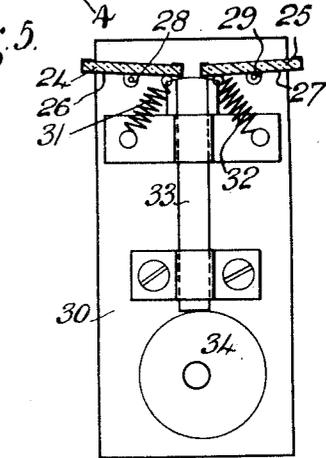


Fig. 3.

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ATTY.

# UNITED STATES PATENT OFFICE

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## APPARATUS FOR USE IN OBSERVING MOVING OBJECTS SUCH AS THE WEB OF A MULTICOLOR OR OTHER PRINTING MACHINE

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R. Hoe & Co. Inc., debtor

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4 Claims. (Cl. 88—14)

This invention concerns improvements in or relating to apparatus for use in observing moving objects, such as the web of a multi-color or other printing machine.

5 More particularly the invention relates to apparatus for use in observing moving objects and which is of particular utility for use in effecting register between the different color impressions in multi-color printing operations on rotary printing presses and for effecting register between a  
10 preprinted inset fed into combination with the product issuing from a rotary printing press.

Multi-color printing on rotary printing presses has always presented very considerable difficulties in obtaining correct register, between successive printed impressions of different colors which have to bear a very accurate registration relation with one another upon each printed sheet of the web fed through the press and even  
15 although devices have been proposed for detecting errors in registration as between impressions of different color and for effecting adjustment between the later printing cylinder or cylinders so as to restore the relationship of the different  
20 impressions to correct register with one another, no really satisfactory solution has actually been employed in practice for high speed work and even in the most up-to-date printing plant operating at slow speeds a very large loss of time  
25 and material is occasioned on the setting up of a rotary color printing press to print new matter before sufficiently accurate registration is attained; often it requires the attendance of as many as eleven operators for a whole day accompanied by the wastage of a complete reel of paper before sufficiently accurate registration is attained. Even when such accurate registration is attained, the disadvantage arises that owing to the long path taken by the web through the drying and other treating operations after it leaves  
30 the printing cylinders, an examination of the product at the outlet end of the plant with a view to detecting lack of registration between the several impressions of different color would entail a large waste of material and introduce  
35 a considerable time lag in correcting any lack of registration which may develop and it is the practice to slow the printing press down periodically to a speed at which the impressions can be followed with the eye with a view to detecting  
40 lack of registration and then increasing the speed of the press back to normal.

Moreover, the difficulties in effecting registration are aggravated by the fact that it is possible  
45 for the impressions to be out of register with

one another both longitudinally and laterally of the web, thus necessitating correction in both these directions.

The invention provides an apparatus which, whilst of general application, enables effective  
5 register in multi-color printing operations and in setting operations upon a rotary printing press to be attained and overcomes the disadvantages referred to above. The apparatus enables the state of registration between the impressions of  
10 different color to be observed and for errors in registration, when observed, to be corrected with precision both longitudinally and laterally of the web during the entire printing operations, whilst the press is running continuously at high  
15 speed. The invention enables newspapers to be printed with multi-colored pictures on ordinary high speed newspaper rotary printing presses, which has heretofore not been successfully  
20 achieved.

In its broadest aspect the invention comprises an apparatus for use in observing a moving object and which comprises an optical system arranged to produce a visual image of the object to be observed and including means arranged so  
25 to compensate for the movement of the object as to eliminate such movement from the image and cause it to appear in a stationary position during a substantial movement of the object.

According to a further feature of the invention,  
30 there is provided an apparatus for use in observing a moving object which comprises an optical system arranged to produce a visual image of the object to be observed and at least an element of which is adapted to be driven in synchronism  
35 with the moving object in such a manner that the movement of the object is so compensated in the optical system that the image appears stationary during a substantial movement of the  
40 object.

According to another feature of the invention, there is provided an apparatus for use in observing a succession of similar moving objects, which comprises an optical system arranged to produce  
45 successive visual images of the objects to be observed and at least an element of which is adapted to be driven in synchronism with the moving objects in such a manner that the movement of the objects is so compensated in the optical system that each successive image appears stationary during a substantial movement of the  
50 object and all the images occupy the same observed position and are of such a duration individually as to cause the periods of the successive images to adjoin or overlap one another or to  
55

follow one another within the period of the persistence of vision of the human eye.

The invention further consists of a method for effecting register between successively printed impressions of different color upon a web of material in rotary printing presses provided with regulating means for effecting an adjustment between the relative positions of the said impressions, which comprises the steps of (a) printing associated registration indices of the different colors on the web from the printing cylinders of the respective impressions, the said indices having a predetermined positional relationship with one another when the impressions are in correct register; (b) observing the positional relationship of the said indices by means of an optical system which effectively counteracts the effect of the movement of the indices and (c) upon the occurrence of an observed relative displacement of the indices, effecting an adjustment of the regulating means to restore the associated indices to their predetermined positional relationship and thus the impressions to correct register.

It is to be understood that the indices may be comprised by portions of the different colored impressions themselves if it should be convenient to do so.

A preferred form of the apparatus for carrying the above method in accordance with the invention into effect, consists of an optical system at least an element of which is adapted to be driven in synchronism with the press in such a manner as to be operable to produce a stationary observable image of the associated registration indices during a substantial movement of the said indices with the printed web after it has issued from the printing cylinder for the colored impression last to be printed of the impressions between which registration is to be effected, and so that the successive images occupy the same observed position and thus give the semblance of a persistent image.

The element of the optical system, such as a movably mounted lens or mirror or a combination thereof, which is adapted to be driven in synchronous movement with the printing cylinders of the press, is driven in such a manner and at a speed which counteracts the effects of the movement of the associated registration indices with the web and so produces the stationary image of the indices.

Such apparatus presents the advantage of a clear and persistent image of the associated indices, which considerably facilitates the observation of any relative displacement thereof when such observation is effected by eye, as is preferred, and thereby facilitates the manual adjustment of the regulating mechanism for restoring any lack of registration which may develop between the different impressions.

It is possible, however, for the observation of the associated indices to be effected by a light sensitive device such as a photoelectric cell device and in this case the persistence of the image or successive images of substantial duration of the associated indices provided by the form of optical system described is of particular utility as it ensures a rapid and accurate response of the light sensitive device and the regulating mechanism controlled thereby to effect any necessary corrections in registration between the different color impressions.

In order that the invention may be readily understood one form of construction of apparatus in accordance with the invention will be described

by way of example with reference to the accompanying drawing in which:

Figure 1 is a side view of the optical apparatus according to the invention, the drawing being diagrammatic,

Figure 2 is a side view of the cam and lever control apparatus,

Figure 3 is a plan view partly in section of the casing which carries an oscillatable mirror, and the cam and lever control apparatus, and

Figure 4 is a diagram illustrating indices on a movable band for detecting errors in registration.

Figure 5 is a diagrammatic view of a modified arrangement.

As shown in Figure 1, the optical apparatus consists of a box or casing 1, in which is arranged a pivotally mounted plane mirror 2. The mirror 2 is mounted on a robust oscillatable shaft 3 with parts of reduced diameter carried by suitable bearings in the casing 1. In the arrangement shown, the mirror is directed downwards towards the face 4 in which is a slot (not shown) through which incident light may pass to the mirror. After reflection on the mirror 2, the light is arranged to pass through a lens system 5, 6 of known form, and is reflected by an adjustable mirror 7 so as to be observed as a magnified image at the eye-piece 8. The casing 1 may be provided with a cover glass for the face 4 to exclude dust.

Referring to Figure 2, which is intended to show details of the mechanism for rocking the mirror 2, it will be seen that the shaft 3 is provided with a lever 9 clamped thereon. The lever 9 is provided with an adjustment 10 to enable the angular relation between the said lever and the mirror 2 carried by the shaft 3 to be varied as required. The lever 9 carries a roller 11 which is normally in contact with the surface of a snail cam 12. The snail cam 12 is mounted at one end of a shaft 13 carried by the casing 1 and adapted to be driven in synchronism with one of the printing cylinders of a multi-color rotary printing press. The roller 11 on the lever 9 is pressed into contact with the cam 12 by an arm 14 controlled by a spring 15, the arm being rigidly attached to the shaft 3. Another view of the mirror 2 is shown in Figure 3 which also shows the shaft 13 and the cam 12 mounted thereon. The shaft 13 may be driven through a gear 16. Below the mirror is shown the slot 17 which is arranged on the lower side of the casing 1. When the apparatus is in use, the mirror is directed towards a movable object below the slot 17 and when the cam 12 is rotated the lever 9 is caused to rock and thereby causes the shaft 3 and mirror 2 also to rock. If the cam 12 rotates in an anti-clockwise direction as shown, and the mirror is initially at the position 2 as shown, then as the cam continues to rotate, the lever 9 is steadily displaced to the right in Figure 2 and the mirror is rotated to position 2a in a clockwise direction when viewed endwise as in Figure 2. The cam 12 is so shaped that the lever 9 has a quick return motion from its position of maximum displacement. The effect of this is that the mirror 2 also has a quick return motion from its position of maximum displacement to its initial position.

If now an object is arranged to traverse a path in the plane of the paper across the front of the mirror 2 and at the same time the mirror is caused to move in synchronism with and to follow the moving object, the image of the object

in the mirror when seen through the optical system 5, 6, 7 and 8 will appear to be stationary. Thus, for example, if a movable band 20, Figure 4, is provided with an index 21 and the band is caused to move along in a direction from right to left below the mirror 2 in Figure 2 so that the index 21 comes opposite to the mirror 2 in the initial position thereof and if the band 20 then continues to move so that the index 21 moves to the position 22, whilst the cam 12 is driven at the same speed as the cylinder driving the band 20, then the image of the index 21 when viewed in the eye-piece 8 will appear to be stationary throughout the period that the index is moving from the position 21 to the position 22.

When the invention is applied to the problem of effecting registration between the successive impressions of multi-color printing operations upon a rotary web printing press, the printing cylinders for the impressions of different colors may be provided each with a printing surface which includes a part adapted to print an index such as 21 as shown in Figure 4. The printing cylinders may be arranged to produce similar impressions in color to form the associated registration indices on the web and in such a manner that when the successive impressions of different color for example, two such impressions, are in correct registration with one another, the lines of the two index impressions such as 21 will be superimposed upon each other. When, however, an error in registration occurs between the impressions, the indices will become displaced from one another and will be readily observable as shown at 21 and 23 in Figure 4.

In practice, the associated indices may be provided on the web spaced apart by a distance corresponding to one sheet length and the optical observation apparatus is set up in relation to the movable web so that the mirror 2 will follow the movement of the web during the transit of one sheet length and the mirror will then be rapidly returned to its initial position by means of the spring controlled lever 14 to pick up the next successive group of associated indices on the web and will produce a stationary image thereof which occupies the same position in the field of view in the eye-piece 8 as that occupied by the preceding image. By this arrangement the periods during which the successive images are produced, immediately adjoin one another, thus giving the semblance of a persistent image. In practice, instead of using indices such as 21, 23 in Figure 4, the indices may be constituted by similar portions of the differently colored impressions themselves as arranged on the web and these portions may be observed as a steady image in the mirror so that any defect in the registration of the successive impressions can be readily detected.

If desired two optical systems similar to that above described can be used and so arranged as to provide superimposed images to an observer looking through the viewing lens and such superimposed images can be arranged to overlap in time so as jointly to give an uninterrupted image. Two or more such optical systems can be provided, each of which produces an image of the associated indices for a proportionate part of the sheet length of travel thereof in such a manner that the two systems together produce an image of the indices during the whole or the greater part of the said travel thereof.

Such an arrangement is illustrated in Figure 5 in which 24, 25 indicate the two mirrors which

are carried in frames 26, 27 pivotally mounted at 28, 29 respectively in a frame denoted by 30. The two mirror frames are drawn by springs 31, 32 against a rod 33 which is reciprocated by a cam or eccentric 34 rotated by any convenient part which moves in synchronism with the object to be observed. It will be seen that the two mirrors are caused to move synchronously but in opposite directions and hence one mirror will reflect the image while the object is moving towards the apparatus and the image will be reflected by the other mirror when moving away from the apparatus.

When more than two color impressions are to be maintained in register with one another, the indices can either be associated collectively with one another in a single group or they can be arranged in a number of groups located adjacent to one another so that all the groups can be observed together. In this case, the most suitable method is for each group to contain an index impression from the first color printing cylinder and an associated index impression from one or more of the succeeding cylinders the latter being in respect of different cylinders for the different groups.

As it is not only necessary to drive the oscillatable or other movable element of the optical system in synchronism with the revolutions of the printing cylinders of the press and that the angle swept by the said element directed towards the indices on the web must be such as to follow the said indices exactly, it may be desirable to provide adjusting means for regulating the said angle of sweep. To this end, any suitable variable drive can be provided and in the case of the oscillatable mirror, the snail cam hereinbefore mentioned can be arranged to oscillate a lever which is coupled by a link or other means to the mirror in such a manner that the degree of leverage between the cam and the said mirror can be adjusted to effect the desired regulation in the angle swept by the mirror. Such an arrangement is particularly useful when it is necessary to regulate the apparatus for different sizes of printing cylinders.

The apparatus described can also be used for viewing the actual color impressions upon a web during its passage through the press to check the depth of color, so that any regulation of color depth which appears necessary can be effected without slowing down or stopping the press.

What I claim is:—

1. In an apparatus for use in observing moving printed webs having a succession of similar equally spaced objects thereon to determine the registering relation of the objects, means for guiding the web through a straight observable path of travel of given length, an optical system having a reflecting surface, a shaft mounted for oscillatory movement about its axis and operably supporting the reflecting surface to impart oscillatory movement thereto, means for biasing the shaft towards movement in a given direction about its axis, an arm adjustably secured to the shaft and extending radially therefrom, a rotatable cam operable through a complete cycle of operation and operably engaging the arm to rock the shaft so that the reflecting surface is moved in accurate compensating synchronism with the moving objects on the web throughout the complete cycle of operation of the cam and throughout substantially the entire length of the said observable path of travel and then instantly returned to its original position so that each successive image

appears stationary during the entire movement of each object throughout the said observable path of travel and all the images occupy the same observed positions and of such duration individually as to cause the periods of these successive images to follow one another within the persistence of vision of the human eye thereby permitting visual observation of the registering relation of the objects.

2. In an apparatus for use in observing moving printed webs having a succession of similar equally spaced objects thereon to determine the registering relation of the objects, means for guiding the webs through a straight observable path of travel of length at least equal to the distance between adjacent similar objects on each web, an optical system including a reflecting surface mounted for oscillation about an axis, means operating through a cycle of movement to cause the reflecting surface to turn from a determined position in the same general direction as the moving web and at variable compensating speeds throughout the operating cycle to cause the reflected visual rays to accurately synchronize with the movement of the object throughout the said observable path of travel and for instantly returning the reflecting surface to its original position so that the moving objects appear stationary at a point of observation thereby permitting visual observation of the registering relation of the objects.

3. In an apparatus for use in observing printed webs having a succession of similar equally spaced objects thereon to determine the registering relation of the objects, means for guiding the webs through a straight observable path of travel of length at least equal to the distance between adjacent similar objects on each web, an optical sys-

tem including a reflecting surface mounted for oscillation about an axis, a cam operating through a cycle of movement to cause the reflecting surface to turn from a determined position in the same general direction as the moving web and at variable compensating speeds throughout the operating cycle to cause the reflected visual rays to accurately synchronize with the movement of the object throughout the said straight observable path of travel, and means for immediately returning the reflecting surface to its original position so that the moving objects appear stationary at a fixed observation point thereby permitting visual observation of the registering relation of the objects.

4. In an apparatus for use in observing moving printed webs having a succession of equally spaced objects thereon to determine the registering relation of the objects, means for guiding the webs through a straight observable path of travel of given length, an optical system including an optical reflecting surface directed towards the objects and mounted for oscillation about an axis, means operating through a cycle of movement for causing the reflecting surface to swing first in a direction having the same general sense as that of the moving object and at variable compensating speeds throughout substantially the entire cycle of movement and then to return quickly in the opposite direction so that the image reflected by the surface appears stationary at a point of observation throughout the observable path of travel of each object to permit visual observation of the registering relation of the objects, and means for producing a magnified image of the object reflected by the optical reflecting system.

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