Nov. 28, 1961 J. D. EISLER ET AL 3,011,145

PHOTOGRAPHIC PRINTING SYSTEM FOR CHANNELIZED MULTIPLE TRACE RECORDS

Filed Nov. 29, 1957 5 Sheets-Sheet 1

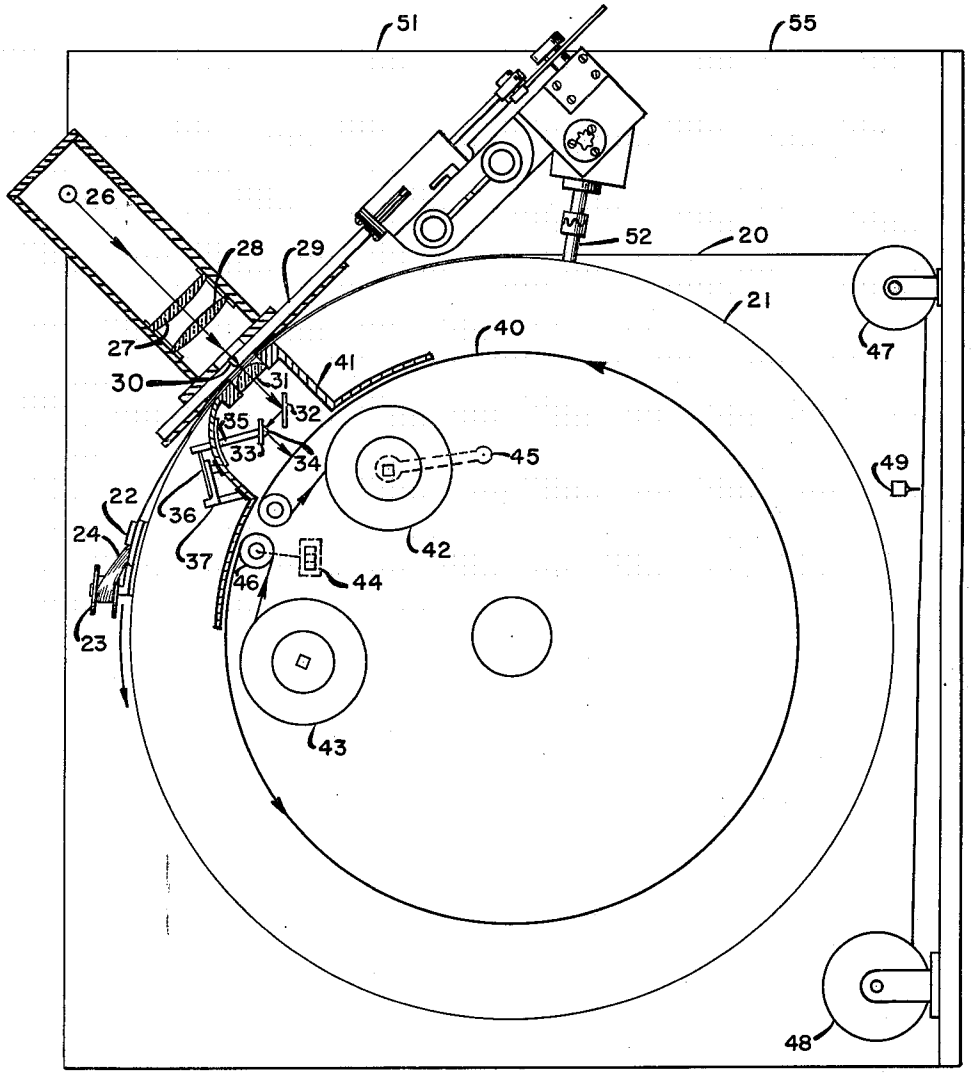


FIG. 1

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PHOTOGRAPHIC PRINTING SYSTEM FOR CHANNELIZED MULTIPLE TRACE RECORDS
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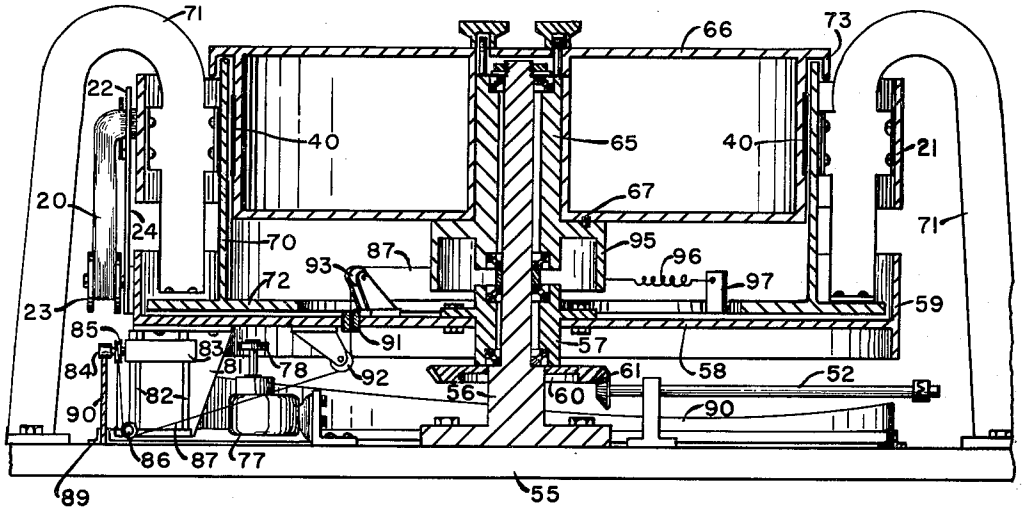


FIG. 2

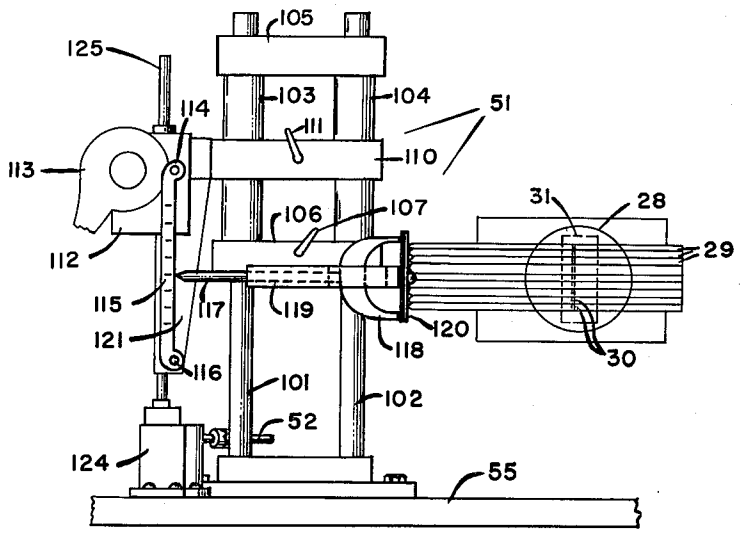


FIG. 6

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PHOTOGRAPHIC PRINTING SYSTEM FOR CHANNELIZED MULTIPLE TRACE RECORDS

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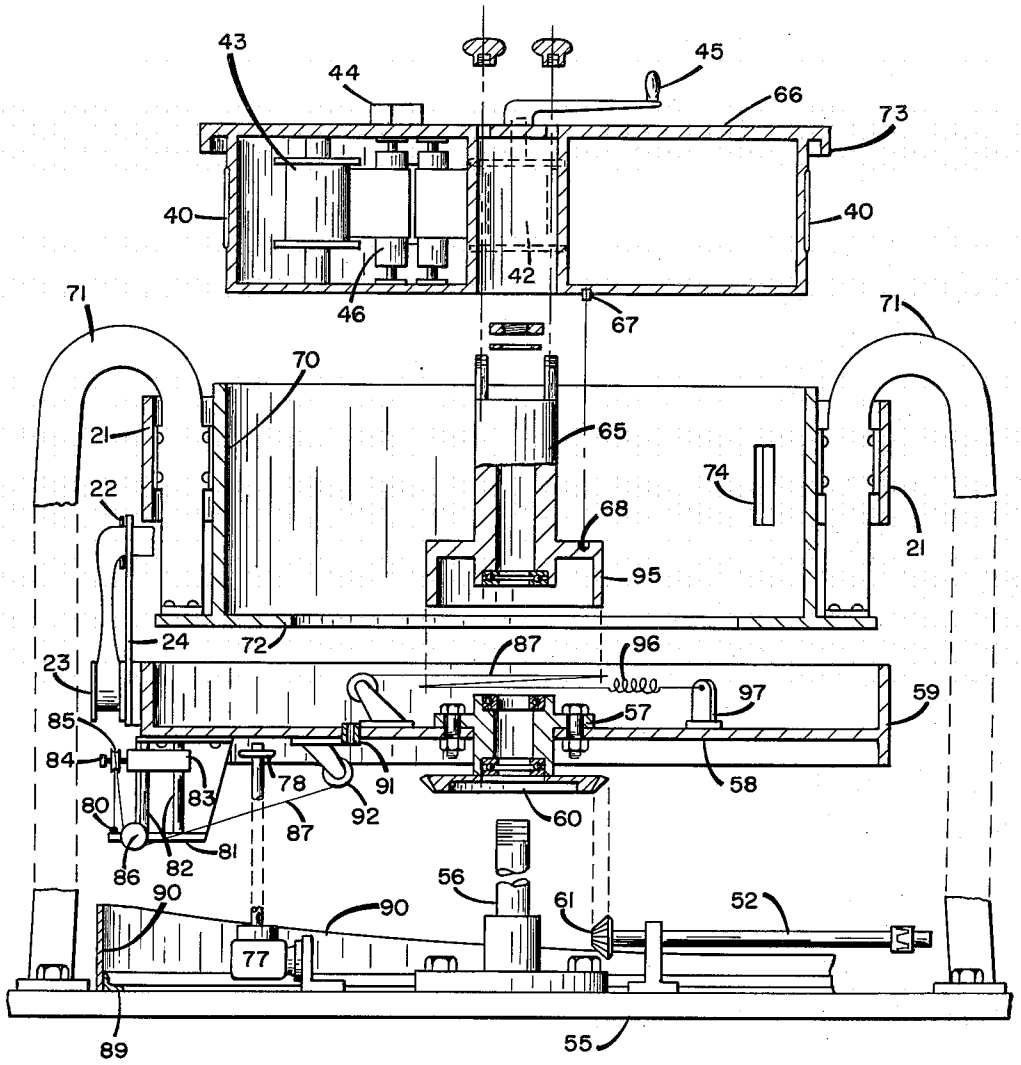


FIG. 3

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PHOTOGRAPHIC PRINTING SYSTEM FOR CHANNELIZED MULTIPLE TRACE RECORDS

Filed Nov. 29, 1957 5 Sheets-Sheet 4

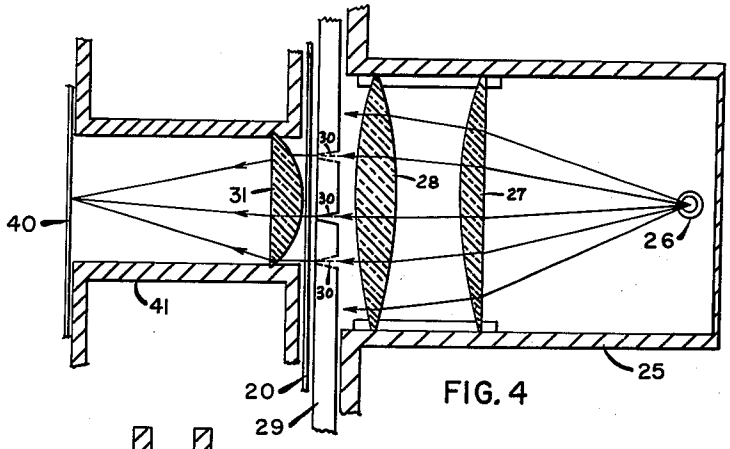


FIG. 4

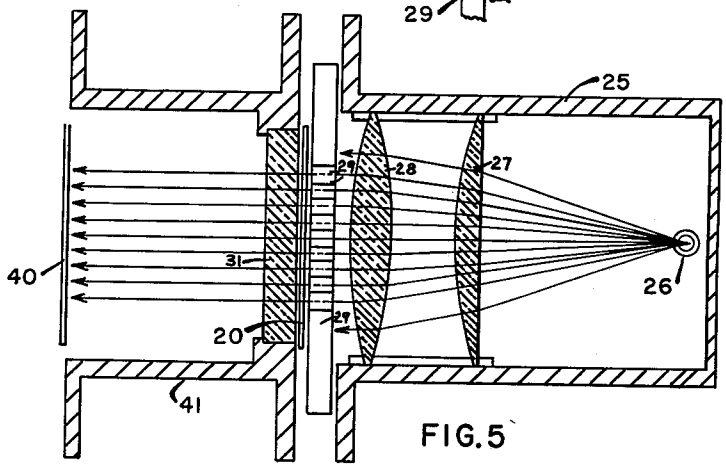


FIG. 5

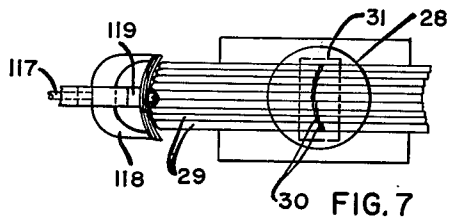


FIG. 7

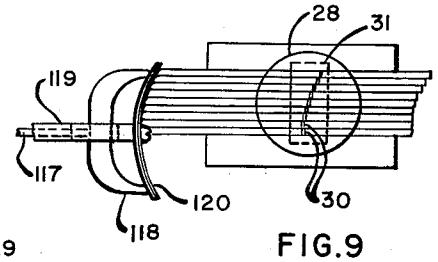


FIG. 9

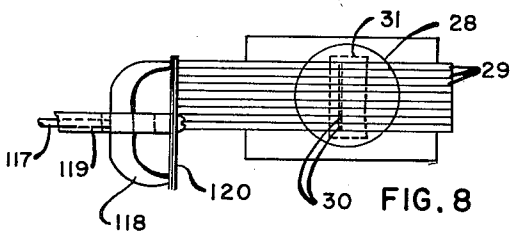


FIG. 8

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PHOTOGRAPHIC PRINTING SYSTEM FOR CHANNELIZED MULTIPLE TRACE RECORDS

Filed Nov. 29, 1957 5 Sheets-Sheet 5

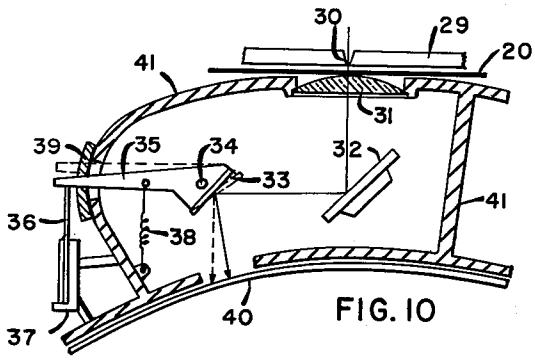


FIG. 10

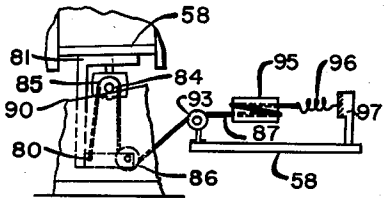


FIG. 14

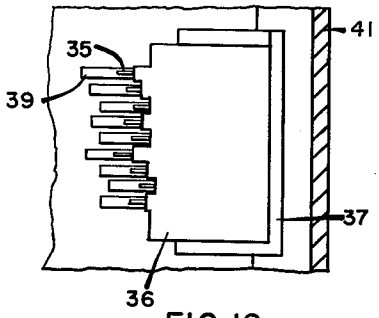


FIG. 12

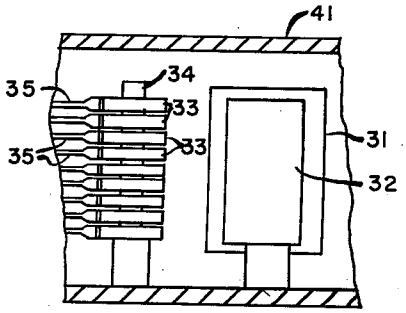


FIG. 11

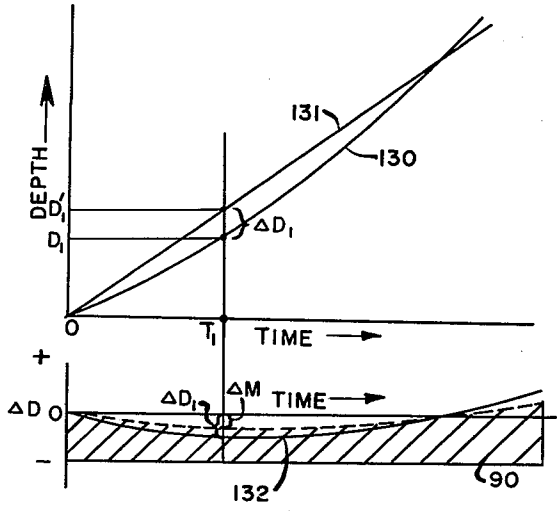


FIG. 13

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3,011,145

PHOTOGRAPHIC PRINTING SYSTEM FOR CHANNELIZED MULTIPLE TRACE RECORDS

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Filed Nov. 29, 1957, Ser. No. 699,753
7 Claims. (Cl. 340—15)

This invention relates to seismic geophysical surveying and is directed particularly to the display of seismic geophysical data. More specifically, the invention is directed to a system for making records suitable for use in cross-section displays in channelized-trace form by compensating or correcting channelized-trace field or playback records for both fixed and varying trace-time differences. If desired, the records can be corrected also for non-linearity of the relation between trace times and depths of geologic boundaries.

The term "channelized" is used herein in the sense that the various traces of a record are confined to individual parallel bands or stripes that extend along the record without lateral overlapping. Variable-density traces are an example of this, and constitute the preferred form of recording for use of this invention, but it is obviously not necessarily limited thereto.

As a result of many years of intensive seismic geophysical surveying, a tremendous amount of data has been accumulated covering many geophysical regions. At times, not all of the recorded information is being utilized simply because of a lack of skilled interpreting personnel. As an aid in handling larger volumes of data and to assist less skilled personnel to perform valuable interpretations, attention has been directed to the display of the data in various forms of record cross-sections. Thus, all of the records obtained along a given line of shot points may be placed side by side in a display to show trends which continue across all of the records or only for a few of the traces.

In studying such cross-sections it is highly advantageous not to have to consider the effects of weathering, elevation, and shot-depth variations along the profile line and of normal move-out due to differing distances between the shot point and the various seismometers. The former are causes of fixed, and the latter is the cause of varying trace-time differences for reflected events on a record. With these causes of time variations for a given event on different traces and different records removed, it often becomes much easier to observe significant though obscure line-ups and relationships on the records.

The presentation of the traces in variable-density form is of especial advantage, as the light and dark patterns of events which align themselves resemble in some degree the subsurface stratification being studied. It is also of considerable advantage in perceiving the geological significance of the cross-sections to have the various parts related linearly with depth, rather than compressed at increasing depths as occurs in records made with a uniform time scale.

In preparing cross-section displays, particularly of the variable-density type, using records corrected for trace-time differences, there are two general ways of proceeding. One is to determine and apply at one time all of the corrections for both fixed and varying trace-time differences to all of the traces forming one record. The other is to apply the necessary corrections to the record one trace at a time, readjusting the apparatus and repeating the corrections for each subsequent trace. The first procedure, while requiring more complex mechanism, obviously accomplishes the desired corrections in a minimum amount of time. The second procedure, while

simpler in some of its mechanical aspects, requires more time.

It is accordingly a primary object of our invention to provide a novel and improved transcribing system for optically correcting a number of channelized data traces simultaneously. A further object is to provide such a system which is rapid in operation and flexible in adapting to various arrangements of spreads and shot holes, and wherein all of the corrections required for a given multi-trace record are applied at one time. Still further objects of the invention are to provide such a system with an easily changed time-to-depth conversion means, all without undue mechanical complexity. Other and further objects, uses, and advantages will become apparent as the description proceeds.

Briefly described, the system is one wherein a parallel-trace photographic field or playback record it is desired to correct and transcribe is transported lengthwise across a beam of parallel light rays. A plurality of slit-carrying means extending across the beam and movable in the direction of motion of the field record define the points along the various traces which are simultaneously scanned. The light rays passing through these slits, as modified by the corresponding respective record traces, are projected toward a lengthwise-moving unexposed film strip along a single straight line transverse to the strip. During the transcribing of each record, the slit-carrying members and slits are moved lengthwise relative to each other by an appropriate adjustable mechanism by amounts adapted to compensate for the normal move-out of the recorded seismic signals. Additionally, the beam from each slit may be deflected so that its final position of incidence on the unexposed film is displaced from the transverse straight line by a proper amount to compensate for the ordinary fixed trace-time differences. Preferably, but not necessarily, the field record and the unexposed film are transported along parallel paths or tracks which are circular and concentric.

Ordinarily, field records have a linear time scale. When it is desired to convert from such a scale to one that is linear in depth in accordance with a given non-linear time-depth curve, the driving connection between the field record and unexposed film travel paths is varied in length by suitable means such as a cam arrangement. This will be better understood by reference to the accompanying drawings forming a part of this application, in which drawings:

FIGURE 1 is a highly diagrammatic over-all plan view of the apparatus forming the invention;

FIGURES 2 and 3 are respectively assembled and exploded cross-section views through part of the apparatus;

FIGURES 4 and 5 are cross-section views through the optical system respectively at right angles at each other;

FIGURE 6 is an elevation view of the dynamic correction mechanism;

FIGURES 7, 8 and 9 are views of a portion of the apparatus in FIGURE 6 in various operating positions;

FIGURE 10 is a cross-section view through the means for introducing static corrections;

FIGURE 11 is an elevation view of part of the apparatus of FIGURE 10;

FIGURE 12 shows the use of an elevation and weathering-card adjusting mechanism for making static corrections;

FIGURE 13 is a graph showing the relationship of the time-to-depth curve to the means for converting from a linear time to a linear depth scale; and

FIGURE 14 is a detailed view of the linkage mechanism for making this conversion.

Referring now to these drawings in detail, and particularly to FIGURE 1, an uncorrected field or playback film 20 is drawn around a circular path 21 by a movable

arm 24 which holds the film by means of a clamp 22 and supports the free end thereof on a reel 23. It will be understood that the film 20 is one which bears thereon a number of parallel traces of seismic data in channelized, preferably variable-intensity, form. In order to prepare a corrected copy of the film 20 for assembly into a cross-section display, light from an essentially point source 26 is collimated by lenses 27 and 28 into a beam of parallel rays of substantial area. Some of these parallel rays pass through the slit 30 of a slit-carrying member 29 closely adjacent each of the parallel traces of the film 20, there being one such member and slit for each trace, the light emerging from each slit passing through the corresponding film trace and being modulated according to the density thereof, then passing through a cylindrical lens 31 which projects or focuses the rays passing through the various slits 30 and the different traces onto the surface of an inner unexposed film 40 along essentially a single straight transverse line. For the purpose of introducing fixed trace-time corrections, however, each slit-defined beam from the lens 31 is preferably deflected through approximately two opposite right angles by a fixed mirror 32 and a pivoted mirror 33 pivoted at the point 34, passing thence to the face of film 40. The exact angular deflection of each slit-transmitted beam produced by each corresponding mirror 33 is determined by a lever arm 35 positioned by the edge of a weathering card 36 placed in a holder 37 of appropriate location and form.

While many details of the actual construction have been omitted from FIGURE 1 to avoid confusion, it will be understood that the unexposed film 40 is entirely surrounded by a light-excluding housing 41 preventing stray light from striking the film. Unexposed film is carried on a reel 43 inside of the drum 66 supporting the film 40 and passes over a sprocket 46 actuating a counter 44, around the drum and back to a take-up reel 42 which can be turned from outside the drum by a crank 45. The uncorrected field record 20 is normally stored on a stationary reel 48, from which it passes an index mark 49 and around a pulley means 47 before being drawn around the outer circular path close to the slits 30. The relative positions of the slits 30 on the various slit-carrying bars 29 within the parallel light beam area determine the points on the various traces of the film 20 which are simultaneously scanned and transmitted through the lens 31 for focusing thereby on the receiving film 40.

The construction and operation of the film-transporting means will be more easily understood from FIGURES 2 and 3, particularly the latter figure which is an exploded view of the apparatus of FIGURE 2. The entire assembly is supported upon a base 55, the rotatable portions of the apparatus being mounted on a vertical shaft or spindle 56 securely fastened to the base 55. The field film transport mechanism comprises a hub member 57 mounted on bearings on the shaft 56, to which hub is attached a disc 58 provided with an outer cylindrical rim 59. A bevel gear 60 transfers to a pinion gear 61 on the end of shaft 52 extending radially outward from shaft 56 a rotation proportional to the movement of the rim 59.

Also mounted to the shaft 56 is a second hub member 65 carrying the inner film-carrying drum 66, a registering pin 67 on the drum 66 fitting in a hole 68 of the hub 65 so as to orient the two members in a fixed relation.

Between the rotatable upper drum 66 and the lower rotatable rim 59 is a stationary cylindrical shield member 70 closely fitting the outside of drum 66 and supported from the base 55 by a plurality of overhead curved arms 71. An annular disc 72 attached to the base of the shield 70 fits close to but does not contact the disc 58 and rim 59. The shield 70 cooperates with a down-turned flange 73 on the upper edge of the drum 66 to prevent like leakage and fogging of the film 40 which is positioned on the outside of the drum 66. The annular disc 72 in co-

operation with the solid disc 58 and the upwardly extending portion of cylindrical rim 59 similarly form a trap for light which might enter from below. An aperture 74 in the shield 70 past which the film 40 is carried by drum 66 admits the light beams which form the exposed tracks on the film 40. Motive power to operate the apparatus is applied to the lower inside portion of rim 59 by a constant-speed electric motor 77 attached to the base 55 and driving a rubber roller 78 in firm frictional contact with the rim 59. Limit switches, not shown but of any well-known type, may be provided to stop the motor 77 from driving the rim 59 too far in either direction of its rotation.

To the outside of the rim 59 are attached the field film take-up reel 23 and the film-moving arm 24 carrying the clamping means 22. Thus, as the rim 59 is rotated by the motor 77, the arm 24 draws the film 20 around the outer circular path 21 past the stationary optical system and the movable scanning slits 30.

Although the rim member 59 is driven by the motor 77 in a positive manner, the drum 66 on the hub member 65 may rotate with respect to rim 59. For making corrected records to a linear time scale or whatever time scale exists on the uncorrected record 20, it is necessary only to insert a fixed connecting link, not shown, between the disc 58 and the drum-carrying hub 65. However, if it is desired that the record-receiving film strip 40 be moved in a fashion which varies linearly with depth rather than time, some variable linkage between the disc 58 and the hub member 65 is necessary. To accomplish this, there is fastened to the underside of disc 58 at its outer edge a frame member 81 carrying a pair of vertical guide rods 82 along which may travel a carriage 83. On a shaft extending from the carriage 83 is a roller 84 and a pulley member 85, there being a corresponding pulley member 86 in fixed position on the lower end of frame 81. Attached to the frame 81 at the point 80 is a cord or flexible wire 87 which extends around the movable pulley 85 and the fixed pulley 86. The roller 84 is adapted to contact the edge of a cam or template 90 of sheet metal bent in a circle and held in a circular channel 89 fastened to the base 55, the edge of template 90 being contoured in accordance with the time-depth curve in a manner which will be more fully described below. The channel 89 holds the template 90 in a cylindrical form so that, as the disc 58 rotates carrying the frame 81 and roller 84 in a circle, the roller 84 remains in contact with the edge of the template 90.

The flexible cord or wire 87 passes through the disc 58 via a narrow opening 91 designed to prevent light leakage, being guided therethrough by pulleys 92 and 93 mounted on either side of the disc. On the upper side of disc 58 the cord 87 passes one or more times around the outside of a drum 95 fixed to the bottom portion of the hub 65 and is attached to one end of a spring 96. The other end of spring 96 is connected to a post 97 attached to the disc 58.

The manner of operation of this varying interconnection between the disc 58 and drum 95 can be better understood from FIGURE 14. Thus, as the roller 84 and carriage 83 moves the pulley 85 up or down relative to the anchor point 80 and pulley 86, which are transported along a circle parallel to base 55, in accordance with the position of the edge of mask 90, more or less of the fixed length of the cord 87 is included between the anchor point 80 and the fixed pulley 86. This accordingly displaces the end of the cord 87 attached to the spring 96, changing its length, and producing a corresponding rotation of the drum 95. Thus, by properly shaping the edge of the template 90, the drum 95 and the film 40 carried by drum 66 mounted thereon can be moved at either the same or a greater or lesser speed than the speed of rotation of the disc 58 by the motor 77.

The functioning of the optical system is shown more

clearly in FIGURES 4 and 5. Thus, the light source **26** and the collimating lenses **27** and **28** are contained in a housing **25** which is positioned closely adjacent the slit-carrying members **29**. The view of FIGURE 4 is a cross-sectional view similar to FIGURE 1 and demonstrates how the cylindrical lens **31** brings the different portions of the parallel beam transmitted by different ones of the slits **30** through the film **20** to focal points lying along a single straight line extending transversely across the film **40**. As the function and effect of the mirrors **33** and **34** are independent of these portions of the optical system, they have been omitted in these figures.

As appears in the cross-section view of FIGURE 5, which is taken perpendicular to that of FIGURE 4 and wherein the motion of the films **20** and **40** is perpendicular to the plane of the figure, the cylindrical lens **31** does not affect the vertical positions of the parallel-beam portions transmitted by the slits **30**, so that the various tracks on the film **20** are transmitted by the lens **31** to the film **40** without altering their vertical separations. Thus, the positions and spacing of the individual tracks on the film **40** are the same as on the film **20**, but the relative times of occurrence of given events on the different tracks of the film **20** can be altered on the film **40** by differently positioning the various slit-carrying members **29** in the manner shown in FIGURE 4.

The detailed construction of the normal move-out correcting mechanism **51** is best shown in FIGURE 6. By "normal move-out" is meant those trace-time differences which are due solely to the location of different seismometers at different distances from a shot point, and the correction, which varies with time along the record, preferably consists of shifting all events to the times at which they would have been recorded with the seismometer at the shot point. Mounted on the base **55** are a pair of vertical guide rods **101** and **102** along which can slide a pair of tubular guides **103** and **104** which with their end members **105** and **106** form a rigid movable frame. A locking lever **107** on the frame member **106** locks the frame in any desired vertical position along the guides **101** and **102**. Mounted so as to slide vertically along the tubular guides **103** and **104** is a carriage member **110** adapted to be locked at any desired position on these guides by the lever **111**. Attached to the carriage **110** is a gear box **112** carrying the cam **113** which bears against a cam follower **114** at one end of a lever **115**, pivoted at point **116** to an arm **121** supported from the carriage **110**.

Bearing against the side of lever **115** is a push rod **117** attached at its other end to a fork **118** and guided for lengthwise movement by a guide **119** attached to the frame member **106**. The ends of fork **118** are adapted to press against the ends of a plurality of leaf springs **120** attached at their centers to the guide member **119**. The face of the leaf springs **120** is in contact with the ends of the slit-carrying rods **29**.

The cam **113** is movable in accordance with the rotation of the disc **58** through the shaft **52** driving gearing **124** which in turn rotates a splined rod **125** engaging the gearing in box **112** to which the cam **113** is connected. Thus, a positive driving connection is maintained between the film **20** moved by the disc **58** and the cam **113**, regardless of the vertical positioning of the carriage **110** on guides **103** and **104** or of the tubular frame along the guides **101** and **102**.

The operation of this mechanism is shown in FIGURES 6, 7, 8, and 9. The film **20** is preferably moved in the opposite direction to that when it was recorded, by aligning the time break defining zero time with the index mark **49**. Thus, starting with the slits **30** aligned as in FIGURE 6, and with the array of slit-carrying rods **29** centered with respect to the leaf spring **120**, the move-out correction corresponds to the reflection from a very deep horizon for which there is nearly zero trace-time difference due to the normal move-out effect between the center

of the spread and the seismometers farthest from the shot point. For reflections from increasingly shallower horizons the corrections become larger and the spring **120** is deformed, moving the slit rods **29** as shown in FIGURE 7. In this figure the outer guide rods **29** of the array correspond to the seismometer positions farthest from the shot point, the entire array corresponding to what is normally called a split spread.

To accommodate another spread configuration such as an end-offset spread, in which the shot point is displaced from one end of the spread rather than opposite its center, the configurations of the spring **120** and the array of slit rods **29** are as shown in FIGURES 8 and 9. Thus, with lever **107** released, the entire frame **103, 104, 105** and **106** is moved vertically with respect to the positions of the ends of the slit rods **29** until the center of the spring **120**, corresponding to the shot point position, is opposite the slit rod **29** of that seismometer of the spread closest to the shot point. For zero correction of reflections from great depths the slit rods **29** are positioned as in FIGURE 8, while for the substantial amount of move-out correction needed for reflections from shallow depths the positions of the rods and deflections of the spring **120** are as shown in FIGURE 9.

Releasing the locking lever **111** and shifting the position of the carriage **110** along the tubular members **103** and **104** comprises the spread length adjustment. By this movement the point of contact of the rod **117** is varied along the edge of the lever **115**. Thus, with the contact point at the lowest position a minimum fractional part of the motion of the cam follower **114** is transmitted to the fork **118** and springs **120**, while with the upper end of lever **115** contacting the end of rod **117** the maximum movement is imparted to the rod **117**. This maximum movement is made sufficient to correct for the move-out of the seismometers which are at the maximum distances from the shot point ever likely to be employed. Intermediate positions of the contact between rod **117** and lever **115** such as that shown in FIGURE 6 provide the move-out correction for intermediate distances of the end seismometer of various spreads. The actual positions for various spread lengths, or maximum seismometer distances are most conveniently indicated by a scale marked on the face of lever **115**.

As the flexing of the leaf spring **120** in the manner shown by pressure at its ends while supported in the center results in points along the length of the spring lying on various parabolic curves, the endwise movement of any one of the slit rods **29** is proportional to the square of its distance from the center of spring **120**. By designing the outline of cam **113** to correspond to the inverse of the product of depth and velocity, utilizing the relationship between time and depth it is desired to use for a given prospecting area, this entire mechanism approximates the expression

$$\frac{X^2}{4DV}$$

where X is the distance from the shot point to any seismometer in question, D is the depth of the reflecting horizon, and V is the average velocity from the surface of the ground to that depth. As is well known, this expression is, to a close approximation, the necessary move-out correction for the trace recorded by a seismometer at distance X from the shot point in any spread. Thus, with adjustments provided in this relatively simple manner both for the total length of the spread and its location with respect to the shot point, it is apparent that a high degree of versatility is present.

Besides the dynamic correction for move-out due to distances between the shot point and the seismometers, it is also necessary to be able to apply fixed values of correction to the traces made by various seismometers of a spread to compensate for variations of weathering thickness beneath the spread, elevation of any particular

seismometer with respect to the shot point, depth of the shot in the shot hole, or travel times from the various seismometers and the shot to a reference datum plane. In FIGURES 10, 11, and 12 is shown in more detail the arrangement of the mirrors **33** and **32** of FIGURE 1 for accomplishing this result. Thus, all of the slit-defined beams from lens **31** are bent through approximately a right angle by the fixed mirror **32** and impinge on a plurality of individual mirrors **33** pivoting on the shaft **34**. Each of the mirrors **33** intercepts one of the beams and is provided with arm **35** projecting through a slot in the wall of the light-tight housing **41** into contact with the edge of a weathering card **36** in a holder **37**. A tension spring **38** holds the end of each arm **35** against its corresponding portion of the weathering card **36**, while a slide **39** attached to the arm **35** prevents light leakage through the slot into the housing.

As was stated and appears most clearly in FIGURE 11, each small mirror **33** is positioned to intercept a different one of the beams from the scanning slits **30**. Thus, each beam is reflected through a different angle depending on the angular setting of the corresponding mirror **33** in accordance with the position of the end of the corresponding arm **35** against the weathering card **36**. This card may be of the form shown in FIGURE 12 where the edge has been cut in an irregular fashion depending on the correction pattern desired by a punching or cutting means of any known conventional type, so that the end of each lever **35** is accurately positioned for the total fixed correction desired. It will be understood that this will include all fixed corrections required by the profile record, and thus may include besides weathering variations, corrections for elevation, shot depth, datum plane, and the like.

In FIGURE 13 is shown graphically the relationship of certain variables utilized in converting from a scale linear in time to one that is linear in depth according to a given time-depth function. Thus, the graph line **130** represents the time-depth curve which is desired to approximate by design of the template **90**. The curve **131** is any assumed relationship between time and depth having a constant slope which is an average value of the slope of the curve **130** over the range of interest. Thus, the actual depth D_1 corresponding to any time T_1 is the same as the depth D_1' read from the curve **131** at the time T_1 corrected by adding an increment ΔD_1.

The bottom portion of FIGURE 13 shows the value of ΔD_1 as a function of time which is determined from the plot of curves **130** and **131** in this manner. It is this curve **132** which has the same shape as the edge of the template **90**, shown as the dotted line and cross-hatched portion of the lower part of FIGURE 13, except that due to the particular arrangement of pulleys and anchor point shown, such that the movement of the cord **87** is twice that of the roller **84**, the deviation ΔM of the edge of the mask **90** from a straight line is only one-half of ΔD. As will be obvious, this shaping of the edge of the template **90** must further take into account the scale factor between the diameter of the film drum **66** and the cord-winding drum **95**. That is, the value of ΔM must be reduced by this further factor.

In operation, with the arm **24** in starting position, the field film **20** is moved to align the time break with the index **49** and clamp **22** is closed to grip the film **20**. Slit rods **29** are aligned as in FIGURE 6. The appropriate weathering card **36** for the particular film **20** is inserted in the holder **37**. An unexposed length of film **40** is positioned on the outside of drum **66** by turning crank **45** and observing counter **44** until the just previously exposed film is wound on reel **42**. If necessary, the spread length is set by moving carriage **110**, and its position relative to the shot point is set by unlocking lever **107** and appropriately shifting tubular frame **103**, **104**, etc.

Light source **26** is turned on, motor **77** is energized, film **20** is moved around path **21** thereby, and film **40** follows at a varying speed depending on the shape of template **90**, or at a constant speed if the linear time scale is to be retained. Slits **30** move as required to change the positions of relative scanning of the various traces to compensate for normal move-out, so that the timing of events on all traces is as if the seismometers were all located at the shot point. Subsequent records with the same spread configuration are transcribed merely by shifting the field film **20**, winding an unexposed length of film **40** into position, and inserting the proper new weathering card **36** in holder **37**. After all records have been transcribed or the supply of film **40** on reel **43** has been exhausted, the exposed film on reel **42** is removed and developed. After processing and drying, the corrected records are cut apart and placed side by side, aligned on the basis of zero time or any other desired datum, to form the record cross section, or a negative from which such a cross section can be photographically printed.

While our invention has been described with reference to the foregoing embodiments and specific details thereof, it is to be understood that these are for purposes of illustration only and that the scope of the invention should not be considered as limited to these details but is properly to be ascertained from the scope of the appended claims.

We claim:

1. A channelized-record transcribing system, for use with a photographic record carrying a plurality of channelized substantially parallel traces each indicative of a recorded seismic signal, comprising means for moving said record along a prescribed path parallel to said traces, means for simultaneously moving a photosensitive film strip along a second corresponding prescribed path, a stationary optical system at least in part between said paths adapted to project a small part of the traces of said record onto said strip, said optical system comprising a light source and means adjacent thereto for forming light from said source into a beam of parallel rays of substantial area, a plurality of slit-carrying members extending across said parallel-ray beam between said film and said beam-forming means, said members being movable substantially along the direction of motion of said record, and said slits being perpendicular to said direction and within said area, means spaced from said strip for focusing on said strip the portions of said parallel-ray beam passing through different ones of said slits to different parts of said strip along a single straight line transverse to the direction of motion of said strip, means for moving said members relative to each other by amounts adapted to compensate for the normal move-out of seismic signals recorded on said record, adjustable beam-deflecting means between said focusing means and said strip, and means for individually adjusting said deflecting means to displace from said line in the direction of motion of said strip the position of incidence thereon of the beam from each of said slits by an amount sufficient to compensate for the time differences between events on the corresponding trace and on a reference trace.

2. A system as set forth in claim 1 wherein said deflecting means comprises a pivoted movable mirror, and said adjusting means comprises a lever arm, a weathering card, and a holder for said card adapted to hold the edge of said card against, and thereby position, said lever.

3. A channelized-record transcribing system comprising an outer circular track, an inner circular track, means for moving a photographic record around one of said tracks, said record carrying a plurality of channelized substantially parallel traces each indicative of a recorded seismic signal, means for moving a photosensitive film strip around the other of said tracks, a stationary optical system at least in part between said tracks adapted to project the traces of said record onto said strip, said optical system comprising a light source and means for forming light from said source into a beam of parallel

rays of substantial area, a plurality of slit-carrying members extending across said parallel-ray beam between said film and said beam-forming means, said members being movable substantially tangent to the direction of motion of said record, and said slits being perpendicular to said direction and within said area, means spaced from said strip for focusing on said strip the portions of said parallel-ray beam passing through different ones of said slits to different parts of said strip along a single straight line transverse to the direction of motion of said strip, and means for moving said members relative to each other by amounts adapted to compensate for the normal move-out of seismic signals recorded on said record.

4. A system as set forth in claim 3 wherein said slit-carrying member-moving means comprises a cam of radius varying proportionately to

$$\frac{1}{DV}$$

where D and V are respectively the depth and average velocity to said depth of a given time-depth function, means for rotating said cam in direct proportion to the movement of said record, a follower in contact with the edge of said cam, and means for transmitting a fractional part of the motion of said follower to said slit-carrying members, said fractional part varying approximately in proportion to the square of the distance between the seismometers corresponding to said channelized traces and the shot point used in making said record.

5. A system as in claim 4 wherein said motion-transmitting means comprises a lever actuated by said cam follower, a leaf spring contacting the ends of said slit-carrying members, and means for transmitting the motion of a point between the pivot point of said lever and said follower to the ends of said spring simultaneously.

6. A system as in claim 5 including means for adjustably changing the position of said point along said lever in proportion to the distance between said shot point and the seismometer farthest therefrom.

7. A system as in claim 5 including means for positioning said leaf spring and the motion-transmitting means coupled thereto so that the slit-carrying member corresponding to the seismometer nearest said shot point is nearest the center of said spring.

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