THE IMPORTANCE OF INTERLACED SCANNING

A television pioneer who, in 1931, set the entertainment world agog when he demonstrated 10 x 10 ft. images on the stage of the Broadway Theatre, New York, discusses in this exclusive article to Radio-Craft one of the most vital developments in television technique.

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INTERLACED scanning is a subject about which we today hear a great deal. Those who have not pioneered television would be inclined to think that this is something new, but interlacing has been investigated over a period of many years, and in fact, the quantitative constants have been rather well established.

Those engineers who have concentrated chiefly upon some of the electrical phases of television without much considera-

Fig. 1. The effect on the image of current lag in the amplifier.
tion of the scanning system are naturally surprised to find an improvement when they simply interlace the scanning lines alternately with each successive scan. Now, interlaced scanning is an old story to the partially initiated if we call it "offset scanning." In fact, an interlaced scanning system of the type up for consideration at the present time is simply another edition of the old 2-spiral offset scanning disc, which many years ago was shown to be a disadvantage rather than an advantage, for here the picture appeared to "wriggle" within itself at very high scanning speeds rather than to flicker "over all" like a single-spiral scanning disc did.

ADVANTAGES OF INTERLACED SCANNING

In our own laboratory, we first adopted a 3-spiral offset system as part of a system several years ago we called "definition multiplication" and "frequency interposition" although many better combinations were possible, but this one was "framed" easily. These offset systems of scanning, when properly used, contribute much to the art of television. The advantages are listed in Table I.

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TABLE I
1. A much lower scanning speed.
2. A smaller eye strain.
3. A faster permissible motion of the image.
4. The elimination of the picture "flash" when the eye winks.
5. A higher fidelity of the probable image when using an accelerator-aided electrical amplifying system.

In other words, offset scanning is an engineer's number one asset, and plays an important part of a profound knowledge of television. It can not only be casually adopted in its most unpleas-
ant form by hopping to it to yield suitable results. It is easy, when scanning elec-
trically, to simply interlace the lines of any 2 alternates, pick the second or the third-
"spiral effect" (of the mechanical scanner). While such alternate interlacing gives a higher fidelity of the same image, it is only because such observations are being made for the first time by those particular engineers concerning the advantages of the "line waveform interpo-
tion of different lines" (or Interlaced scanning) in television signals. This simple single offset-
ing reveals the advantages of a small amount of waveform interposition while suffering an optical disadvantage in the scanning system itself, and therefore these engineers are going to a higher and higher number of scans per second. It has been unpleasant to listen to some engineers speak of the number of scans per second as though television engineers had fre-
quency to "burn"; and fidelity so fine as to necessitate practically putting the image out of focus in order to avoid unpleasant sharpness. Such is definitely not the case, and we must con-
serve every spot of the television picture and cause it to recur as infrequently as possible as long as we retain a thoroughly acceptable ef-
fect. In other words, using ordinary American business intelligence in our television engi-
nering, we must make our picture definition cost us as little as possible.

CAUSES OF FOGGED IMAGE

Now the reason for picture line frequency inter-
position in television can be illustrated very
simply—The probable image is a person's face —that is, although we must resolve every con-
celvable type of image, the human face is the
most probable. Therefore, the scanning system producing the probable frequency will probably develop this principle of frequency by scan-
ing a face. The face, if traced with an ordinary simple sequence (or non-interlaced) scanning system, there is a similarly similar waveform se-
quence in the electrical system, for each line-
tracing across the forehead. The low-frequency (or zero) shading is approximately the same in each case, and therefore, the average voltage developed in an alternating current amplifying system will develop in a general direction which will alter the effective bias on the controlgrid in the amplifying system. Therefore, any sys-

tem using condensers, or a so-called "condenser-
resistance coupled" amplifier, will yield apparent
shadows in the visibility of any repeated wave-
form sequence which is either lighter or darker
than that produced at zero signal level. For
example, if each successive signal increases the
charge in the coupling condenser, which does
not have time to completely leak off between
signals, then a continuous discharging current
will cause a general change in brilliancy in that
zone of the picture where these effects occur.
Thus the picture assumes a striped appearance
having different zones of light and dark shad-
ings.

By reference to Fig. 1A and B, we can easily see that the successive signals from tracing a forehead of a person will produce a change in effective bias voltage on the controlgrid of the electron relay, for the condenser is charged each time, and does not have time to fully dis-
charge, and again balance the circuit to give
normal bias on the control-grid. Hence, zones of
blackness have black shadows, and zones of
whiteness will have white shadows, and at the
depth of the zone, gray shadings will appear
where white is intended. In photography, we
would call this a "fog" on the picture. So let us classify this effect in television as either a
"(1) scanning or (2) electrical fog," for it is due to either (1) improper scanning or (2) im-
proper amplifying technique.

By the use of a so-called "battery balanced
amplifier," or devices that do not involve trans-
formers, inductances or condensers directly in
the amplifying system, we can eliminate these undesirables effects from the picture. Such ampl-
ifying systems have so far been expensive, and somewhat unstable in operation. To over-
come this unpleasant effect with an amplifier in
the task of the television engineer when he is
working on amplifiers, but when the television
engineer is working on scanning systems, then
he should reduce this displeasing effect with the
proper scanning system, in which (1) "scanner
fog" may be eliminated; and (2) "elec-
trical fog" is isolated and treated by itself.

A noticeable improvement in fidelity is immedi-
ately effected when a television engi-
nier omits every line on one scan of the im-
age and inserts it with the next scan, alter-
nately interlacing or off-setting, for then the number of repetitions of "forehead signal" or
"their signal," or "mouth signal" are reduced by
50 per cent and "interlaced" with other signals. Optically, this "sharper" or "little
work" appears to move to the top, and the
scanning system really has to trace very rapidly to effect a pleasant optical signal. Now, if
we set off 3 lines so that we leave out every 8
adjacent lines, then a much more acceptable optical effect is achieved while tracing the pic-
ture at a fairly low scanning speed, and at the same time a lesser number of repetitions of the
same type of signal occurs in sequence; thus, only a few lines have "forehead signal" before
they are followed with the signal produced from the eyes, or the teeth, etc.

Visible improvement in fidelity continues as we increase the number of offsets, but the optical
advantages of offsetting decrease if we fol-

ominate that the optical and electrical effect is ob-
tained when we scan sections of the picture as
widely separated as possible with each successive
tracing of a line of the picture.

RHYTHMIC—UNRHYTHMIC SCANNING

Thus, we scan first a line at the top of the picture, and then at the bottom, but now if we
should alternately go back to the top and then
the bottom and weave in toward the center, the
effect would be good in the system. Now if we
repeat the same general effect, filling in the
lines that have not been scanned, and in this
fashion, we continue until we have scanned every line of the picture with the scanning spot.

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DEFINITION MULTIPLICATION

Now great advantage is obtained if on the
next complete cycle of scanning events, we
cause the lines to be "half-offset" so that they
trace in the manner shown in Fig. 2A.

The center of definition has now shifted to the
point where absent lines formerly existed, and
this "invisible offsetting" greatly reduces the
apparent grays in the picture so that it can be
made to appear extremely smooth. We call this "invisible offsetting" definition multiplication,
for in effect, it takes a fixed line work, and
puts it into a state of motion. This effect may
be improved with two “invisible offsets” in the manner shown in Fig. 21. Therefore, by operation of these two methods of scanning in cooperation, we achieve both the advantages of definition multiplication and line frequency interposition; or in other words the best optical effects and the best electrical effects. Hence, by the application of such a system we can say, “we have made television scanning progress.”

That is, we can scan and produce the optimum definition with the minimum speed, with the minimum electrical frequency, and the cheapest possible electrical amplifying systems; and with devices which might otherwise have too much inertia for improperly-engineered, higher-speed systems attempting to produce the same definition at the same frequency.

The means by which these methods may be accomplished are numerous. It is not confined to mechanical scanning, and they may be just as easily applied to electrical scanning. If an electrical scanner like the iconoscope has an image-tracing line sequence which traces the lines in a manner giving the best line frequency interposition for the probable image by offsetting, then the cathode-ray receiver may pick up this tracing signal and trace similarly. It is only necessary that they trace in synchronism and the best visible and electrical effects are, therefore, easily obtained. With a mechanical system, this is simply incorporated in the mechanical design. While we hear much of the glory of electrical scanning these days, and the systems are, undoubtedly, attractive, their fidelity “per spot” is far below that of a good mechanical system; and unless electrical scanning systems can reveal more notable advances and improvements, the mechanical systems still appear to play a serious part in eventual television—particularly, where large pictures are desirable. Lamb’s polarizing film now offers immense new possibilities to large-screen mechanical systems giving extremely high definition, for the screen itself may be used as the light valve. It is quite possible that an electrical transmitter like the iconoscope can be made to work successfully with a mechanical receiver, but whatever system is adopted as long as it scans, electrical advantages are obtained by scanning the probable image so as to effect line frequency interposition of the dissimilar waveforms, and to secure improved definition and agreeable effects with the properly coordinated sequence of scanning and invisible offsetting.

Television is a broad science, and it is not “solved” by the contribution of any one type of tube, or a scanner, or any one of its component parts. Like all the other engineering arts, it has many phases. Since the art is young, we are all occasionally inclined to overlook its enormous scope. Therefore, we must choose any standard of scanning at this time with a more scientific attitude than that with which we approached experimental standardization some years ago when single-spiral scanning discs were adopted while now all turn directly to offsetting. Standards unwise selected will be expensive, and as distressing as the 60-cycle hydro-power systems are in the midst of 50-cycle practice.